JOURNAL

OF

INDIAN INDUSTRIES AND LABOUR.

Vol. I, Part 1.] 1921 [February.

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Decentralisation of authority and responsibility must necessarily tend to give rise to local variations in policy, apart altogether from those variations that necessarily follow local diversity in natural resources. Thus, there arises at once the necessity for designing some machinery to facilitate voluntary co-operation and mutual understanding; for no province can be entirely self-contained in those matters that affect the development of industries on modern lines. For the essential communications, for accessory raw materials, for markets, for financial aid, and even for unskilled labour, one province must rely on the resources of another. Industries do not flourish singly but in family groups: provinces do not develop singly but in federal associations.

As one step towards provincial co-operation, this *Journal* has been established at the special and unanimous request of the Provincial Directors of Industries who have met in conference on two occasions during the past year. But, in addition to its functions

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as a bond of union between those who are working towards similar ends in different provinces, it is intended as a medium for communicating to a wider public, within and outside India, information that will assist private enterprise.

The *Journal*, so far as industrial questions are concerned, will be general in composition; but separate *Bulletins* will be issued also at irregular intervals, and these will deal with specialised subjects in monographic form for the help of those who wish to limit their interests to special lines of work. As the object in view for these publications is simply the dissemination of information, private journals are at liberty to reproduce their contents freely.

DELHI, T. H. HOLLAND.

1st February, 1921.

THE POSSIBILITIES OF INDUSTRIAL DEVELOPMENT IN THE CENTRAL PROVINCES AND BERAR.*

BY

Sir C. E. LOW, K.C.I.E., I.C.S.

The three factors on which industries depend are materials, men and money. Each of these is necessary to the end we have in view and we are not likely to attain any large measure of industrial development, unless the best use is made of each.

Materials, in the Central Provinces and Berar, fall under the three main heads of agricultural, forest and mineral products. Of these three, here, as in most parts of India, the first is by far the most important, and the most important of the agricultural products from an industrial point of view is cotton. The Central Provinces cotton is roughly speaking all of short staple. The actual *quantity* produced may be increased very considerably by scientific research and by an improved system of rural economics, which will increase the supply of manure and render more intensive cultivation possible. This is fairly certain to come about in the ordinary course of things with the stimulus of modern scientific and economic development and competition with the rest of the world, granted in India stable political conditions and continued peace and security, just as it came about in Europe between the seventeenth and nineteenth centuries, and is, in fact, still developing. The outturn of wheat in medieval England was about the same as in the Central Provinces, or about 600 lbs. to the acre. It is now three times that in England. The increase was due to better cultivation, more and better manure and better cattle. These again were due to the growth of fodder crops, rendered possible by the amalgamation of scattered holdings and the enclosure of fields by hedges. The cattle no longer wandered over the village waste and fallow or stubble fields; but either grazed on carefully kept pastures, or were stall fed on the intensively grown

* This paper is the substance of an address delivered in the Morris College, Nagpur, on 21st January 1921.

products of the farm. This meant larger and better cattle whose manure was more carefully conserved. One of the main problems to be overcome in India is the use of cattle dung as fuel, and its conservation for manure. Another is the poor quality of the cattle themselves. These problems are, I firmly believe, not incapable of solution.

The prospect is less hopeful when we come to consider the possibility of establishing longer staple varieties. There seems some deep-seated relation between the local peculiarities of soil and climate, the concentrated rainfall and retentive soil, and the type of cotton which is grown; and it is doubtful whether a long staple variety can be found that will pay the cultivator better than a short staple. The factor of the retentive soil may be modified by growing cotton on light soil with irrigation, but it is very doubtful whether this will enable cultivators to grow any considerable quantity of long staple at a profit, having in view the limited supply of irrigation, the concentrated rainfall, and the high cost of storage irrigation, if an attempt is made to take your cotton growing season into the hot weather. Some improvement can doubtless be made in the existing staple by scientific work; but not, I hazard a guess, to the extent of evolving from it a definite long staple variety.

The industrial bearing of the foregoing conclusions will be understood, if we remember that the demand for long staple cotton tends to increase as the standard of comfort rises, especially in Eastern countries; and it will not be long before the markets on which the local mills can depend are more or less satiated with short staple products. Further expansion will not then be possible, except by the use of a longer staple.

Another fibre crop that I hope will be one day of considerable industrial importance is Sunn hemp. It is an excellent fibre, much better than jute, but its use is limited by its relatively high price, and its production by the amount of labour and water available for preparing it. The discovery of a mechanical process for separating the fibre would render it possible to do this with a greatly reduced use of water and labour, and would give great encouragement to the extension of this crop. I have some reason to hope that such an invention may not be long delayed.

The production of oil seeds can be increased very largely by a generally improved system of rural economy, and by scientific research. This ought to be directed towards trying to see how and

why a plant produces the valuable material for which it is cultivated, a line on which little has hitherto been done. This piece of fundamental research may not succeed at all and it is certain in any case to take a very long time, while the interim results obtained are not likely to appeal to the popular imagination, and the people's representatives, who will now hold the purse strings, are very likely to grow impatient and refuse to spend more money on it. But it is precisely this kind of fundamental research which leads in many cases to the most important practical results, and those who consider economic improvement a big factor in the political future of the country should not overlook the importance of this obscure, expensive and often unintelligible spade work.

The growing of oil seeds, if the crop is to be as largely exported as hitherto, confers a very restricted benefit on any country, and it is of very great importance to secure that they are crushed and made into oil and its various by-products within the country. It is a well known fact that if oil seeds are exported in bulk, the producing country is deprived of the cake, which is of great value as a cattle food and as a manure. It therefore pays the country much better to crush the seeds locally, sell the cake to surrounding farmers, export so much of the refined oil as the country does not require itself, and use the by-products of the refined oil in soap or other similar manufactures. There are two practical difficulties in the way, the lack of a demand for cake and the high price of chemicals for the further treatment of the oil and its by-products. The extended production and local consumption of oil cake for cattle food and manure is a very important step and it can be furthered materially by the operations of the Department of Agriculture, if sufficient public support is forthcoming. The availability of cheap chemicals is less promising. We shall have acids made in this country shortly, but we cannot yet see our way to a large scale cheap supply of alkalis; and our present outside source of supply, whatever else it is, is not cheap.

The world's demand for industrial alcohol is likely to increase to an extent which no one can at present forecast, and I venture to think that the main sources of supply will be found in the tropics. Sugar cane and *mahua* are at best only limited sources; food grains cannot be spared; and it seems probable that for really large scale supplies we may have to depend on cellulose, the chief structural material of plants, which can be converted into starch and so to

alcohol. Tropical warmth and moisture are very favourable to the growth of large quantities of plant material; and the possibility of growing these, especially if it can be done on land not wanted for other purposes, is a suitable subject for a fundamental research.

The countries which used to take our hides before the war are not doing so now. This is not because they do not want them, but because they cannot afford to pay for them, mainly owing to the depreciation of their currency. This is bound to right itself in time, and then we shall be once more faced with the problem how to bring the exportable surplus of our hides to the highest stage of manufacture before they leave the country. In spite of the difficulties from which the Indian tanning industry is suffering at present, I firmly believe that it has a great future before it. It is unnatural and impossible for this country to continue for ever as a mere exporter of this valuable raw material. India produces by far the greater proportion of the world's output of light hides, which cannot be profitably replaced by heavy ones, and she can in the long run compel protectionist countries to admit her manufactured products. There is an abundant supply of hides and of many kinds of tanning materials, and the prospects for local enterprise are favourable. But I would add a word of warning. The future undoubtedly lies with the large scale enterprise, embodying modern processes under expert control, probably a rapid chemical process. Mistakes in the use of hides are very costly and yet, if the best processes are not adopted, the surplus cannot be exported. It is not only in tanning and leather work that the large scale enterprise, relying mainly on automatic machinery, is bound to hold the field and control the price of products. India has seen a striking instance of this in the competition of the cotton mill with the hand-looms. The industries which can be successfully carried on on a small scale are relatively few.

The problem of improving the manufacture of leather and leather articles is clearly one that must be solved to a large extent by the central Government. The central research tannery that will soon be started in Calcutta under the joint control of the Government of India and of Bengal is the first attempt in this country to do what I have just indicated as necessary, and it cannot fail to be of great assistance. It will also give training not in the mere chemistry of tanning or in small scale working, but in handling hides on the scale of a proper commercial unit of manufacture and will produce

men who will readily obtain lucrative employment. It will be open to men from all provinces in India.

The forests in the Central Provinces, though very extensive, will not for very many years to come figure very largely in the purely industrial economy of the country, though they are of prime necessity for its equally important agricultural and domestic needs. They are not really great sources of supply for commercial timber, though the local conversion of trees into sawn timber may help in this direction. The railways will not be able to rely indefinitely on the supply of timber sleepers. They will have to use more and more iron or reinforced concrete as a material for sleepers, and the timber will be converted into uses for which wood is the only possible material.

We have a few products of a specially valuable nature in our gums and resins. The resin of the *salai* tree, so plentiful in our western districts, has been attracting much attention as a possible source of turpentine and rosin. The large quantity of gummy residue in the resin is, I believe, a drawback, but the possibilities of the industry are promising, and are likely soon to be taken up commercially, in Bombay at any rate. This is not an industry which need be undertaken on a very large scale nor, in my opinion, is there any reason why it should be permanently carried on by Government, though the main source of the raw material is in the Government forests.

The production of lac is well developed in the Central Provinces and is practically an Indian monopoly. Its refinement and subsequent industrial use, however, have not been carried very far in India hitherto. The manufacture of varnishes, though rather a complicated matter, is a promising line of work; but it must be preceded by a good deal of pioneering, which it may be hoped will be taken up by the proposed chemical research institute for all India to be located at Dehra Dun. This kind of work, if trained men are available, can also be taken up on a relatively small scale.

Many aromatic herbs grow in ou forests, some of which are known to contain principles of value as perfumes or drugs, while many more have not been fully investigated. Here too chemical research should be able to point the way to the small capitalist. But technical training is needed for all these industries. I do not think that wood distillation, of which we heard a great deal before and during the war, is a very promising opening here just at present.

War requirements led to its development on a scale bigger than is at present required, and its products do not command a very remunerative price.

The Central Provinces and Berar contain a number of valuable minerals; coal, ores of iron, aluminium and manganese, limestone and ochres being the most important. There is enough coal in the Central Provinces to give a very material advantage to our local industrialists; especially if modern developments in the direction of making more effective use of low quality coal are followed. The most important of these is at present the coal blast, or firing by powdered coal. But our coal is not likely to be of use for metallurgy, and India's great future in respect of iron and steel production must be limited so far as can be foreseen, by the quantity of coking coals available in the coalfields at present worked or believed to exist in Bengal and Bihar and Orissa. In spite of this limitation I think India will be a large producer of iron and steel, and is likely to require a larger proportion of its coal supplies for this purpose than other industrial countries. Metallurgical industries requiring large quantities of good coke are not likely to flourish in the Central Provinces; and hydro-electric power will not be forthcoming on a sufficiently large scale or sufficiently cheaply to supply big electro-metallurgical works of the type that may arise elsewhere in the future. The manganese and aluminium ores will have to go to Bengal or Bombay for treatment; but in return the Central Provinces should receive from these provinces many of the chemicals which the oil, varnish, tanning and other industries stand so deeply in need of. The economic relations between the various parts of India required for the success of industries in any one of them will suffer severely, if provincial patriotism becomes too narrow.

Ochres are also a not unimportant material for paint manufacture. This is a comparatively simple form of industry which has plenty of local experience behind it; and yet capital is not forthcoming locally for any expansion of the existing industry. I have not sufficient knowledge of the circumstances to say if this hesitation is wise or not; but I have noticed on other occasions a great reluctance on the part of Central Provinces capitalists to invest in any form of industrial enterprise, unless they can see at least forty or fifty similar ones in constant and successful operation in their own neighbourhood; thus cotton gins are almost the only industrial investment that the small local capitalist will touch, although he often knows that

the gin he is erecting will stand idle and merely share the profits of an existing pool.

The mineral materials required for the glass industry are coal, sand, limestone, soda, potash and lead. Of these it is necessary to have the sand and limestone available near the factory, as they are used in far greater bulk than the others. Coal which is needed for heating is also used in large quantities. Thus, the three main materials are locally available, and the others can be readily imported. Enormous numbers of glass articles are now turned out by automatic machinery, and the working of a glass factory depends now-a-days far more on the mechanical engineer than on the blower and moulder. Automatic machinery requires very large quantities of molten material, which has to be prepared in long ranges of continuous furnaces. These factories can produce so cheaply, that the small concern which relies on hand work will speedily succumb as soon as the world gets into working order again. Any one who wishes to start a glass works in India must realise that he must put down a costly large scale modern automatic plant, under competent advice and at a place carefully selected beforehand.

The power possibilities of the province are fair. Coal for power and heat production is available in reasonable plenty. The hydro-electric possibilities of the province are not very large, nor very cheap. They will never be cheap enough to use for the production of chemicals; but they ought to be a useful source of power for factories in due course, as industries develop that can be suitably located not too far from your power sources.

So far as railway transport is concerned, the Central Provinces and Berar are not badly off. Its rich cotton tract could support one or two more short lines, and so could the worse cultivated but level and fertile cultivated plain of Chhattisgarh, where a line from Bilaspur to Pandaria or Kawardha would certainly be a success. The parts of the province least provided with transport are the plateau of the Satpuras, and the high ground to the north of the Chhattisgarh plain. The latter will probably be traversed by a railway tapping various coalfields to the west of the Bengal coalfield. The Satpura plateau cannot with our present standard of agricultural production provide enough traffic to justify any more lines through difficult country at the present cost of construction, except from places where minerals are produced. When the line from Itarsi through Nagpur to Warangal, that from Raipur to Vizagapatam, and three

or four short feeder lines in Berar and Chhattisgarh are completed, it will not be possible to build any more lines that will pay for their cost, unless important new mineral deposits are discovered, or it is decided to work the bauxite deposits. Industrial development has not so far been arrested for lack of railway facilities. Much more advantage might have been taken in the part of existing railway lines, by the establishment of rice, flour and oil mills.

But there is a considerable scope for other forms of transport than railways. Ropeways, in the design of which a good deal of advance has been made in recent years, would enable the Forest Department to obtain a larger income from, and the people to make greater use of the forest products. The motor lorry might be employed with great advantage for the transport of cotton, wheat, and other agricultural produce, as well as passengers. Moreover, anything that familiarises the village population with the application of machinery is a useful form of education.

If may be said, then, that though the Central Provinces and Berar possess no transcendently valuable industrial factor, like the Bengal coalfields or the hydro-electric sites of the Western Ghats, or the forests of Burma, yet the Province has a remarkably complete all-round supply of most kinds of industrial materials found in India. Why is it, then, behind most Indian provinces in respect of our industrial equipment? The next part of this paper will deal with this question.

The men who are to use the materials are of two classes, the technical supervisors and the labourers, skilled or unskilled. The important questions for consideration are therefore technical education and the labour question. Regarding technical education, I do not think I can add anything to what has been said in the Industrial Commission's Report. The Commission's most important recommendation, the giving of proper facilities for apprenticeship training at the big railway engineering shops to educated Indian youths, is in actual practice at the E. B. S. Co.'s works and schemes are under preparation for the Ordnance Factories, for the N. W. and E. I. Railway workshops, and for Perambore in Madras. A Committee is being formed in Calcutta to secure proper co-ordination of all the local schemes. Mechanical engineering, more or less specialised, is *the* form of technical knowledge most needed in modern industries, and it is the kind of technical education in which India has hitherto been most lamentably deficient. Four years ago,

there were hardly half a dozen Indian foremen, much less Loco. engineers, in all the railway workshops in India, and yet the number of mechanical engineers in a country is a far better guide to its economic power and therefore to its place in the scale of civilisation, than the number of Government officials, or lawyers. Fortunately, Indians are showing marked signs of losing their previous aversion to this profession, especially in Calcutta, where the change in the attitude of educated Bengali youths between 1914 and 1919 is surprising. Mechanical engineering cannot be taught so as to make a pupil a useful man in a repairing or producing shop except by actual training in a shop run as a business institution. Our engineering shops in India are not, for the most part, engaged in large scale production, for which large numbers of men and much machinery have to be organised to turn out many thousands of similar articles at the cheapest rate and the greatest pace possible. Indian engineering shops are mostly engaged in repairs, or in replacement work, but the increased production of iron and steel will increase production work in our Indian shops very greatly, and an increased demand that will arise for Indian mechanical engineers and mechanics at highly remunerative salaries. There will be fine openings for young men and they ought not to lose them. The Central Provinces School of Handicrafts has already made its mark, both in the province and outside it, and it is likely to be followed as a model in more than one province. Chemistry will soon, it is proposed, be taught on lines and with facilities that will give an industrial direction to the pupil's studies. both in provincial institutes like that contemplated at Cawnpore and by the Government of India at Dehra Dun. It should soon be possible for Indians to get as good a training as is really necessary for any chemical industry practised in this country, without going to England or America or anywhere else. There will be a central institute for tanning and leather work at Calcutta and a scheme is now nearing completion for a School of Mining and Geology at Dhanbad on the coalfields. All these will be freely open to candidates from any province.

Another subject has rapidly assumed increasing importance during the past two years. I refer to labour. Many causes have contributed to this increase. The rise in the cost of living is one. The appearance of India's representatives at the International Labour Conferences held under the covenant of the League of Nations is another. The conventions and recommendations of the

conferences are bound to affect our labour legislation very materially. Politicians have been led to see that the organisation and elevation of labour is a field that cannot be neglected. Labour wants leading; and this can only come from outside sources at present. In course of time education and experience in the management of their own affairs, with which some labour politicians at any rate are endeavouring to associate representatives of the men, will produce leaders from among the ranks of labour, and then the outsider will tend to disappear as a labour leader, unless he entirely throws in his lot with the men he represents. The same was the case in the early days of the labour movement in England. But public men generally, and not only those connected with labour organisation, must take a more direct interest in the education, housing, comfort and general betterment of the working classes. That will be good for themselves and good for labour. Several Acts have been passed in different parts of India enabling compulsory education to be introduced. These have not had much practical result, mainly if not solely owing to lack of funds. Now that education has become a transferred subject, it is up to Indian politicians to show their practical interest in the welfare of the working classes, by securing the necessary funds, and pushing on with the organisation. Not many years ago, I heard Mr. Gokhale speak in the Nagpur town hall on compulsory education. He may have been ahead of the practical possibilities of the time; but we now recognise the great economic loss to India by the unskilfulness of her labour. This can only be remedied by education, by an improved standard of comfort, and by the desire to earn more money by increased efficiency. Employers must recognise all this; and the sooner they do so, the better for their own interests and for the country. The labour movement will give us two important benefits. It will remove the stigma of being a nation of coolies which attaches to India in the eyes of some countries; and it will increase the industrial efficiency of labour, by lifting it from its present low standard of comfort; and will educate it to a desire to increase its earnings by increasing its efficiency. Trade unionism is certain to lead to a pressing demand on the part of labour for education, without which there is little hope for the increased efficiency needed to enable our industries, not only to hold their own in India, but to obtain a share in the world's trade. The waste of man power in India owing to its inefficiency is appalling. Each person employed in agricul-

ture produces less than one-tenth of what such men produce in European countries. An improved agricultural system would obviously release a vast supply of labour for factories.

A free acceptance of the necessity and usefulness of trades unions should not prevent employers from taking steps on their own part to settle disputes and difficulties direct, or to prevent their arising. Works Committees have proved a success in some other countries. They there consist of committees of workmen with or without representatives of the management. They bring to notice hardships, cases of petty oppression, and methods by which waste of work or material may be saved; and they often manage the men's social clubs and recreation funds. In India, we must begin more modestly, remembering that labour is at present uneducated and inexperienced. The Government of India have already set up works committees in the Government presses; and one or two railways and private employers are considering or even actually working similar schemes.

In addition, housing, health, and social welfare are now receiving an increasing degree of attention. But whatever share may be taken in any of these movements by the employers and by Government, both must alike recognise that our industrial prosperity cannot endure, unless our labour force becomes more skilled and specialised, and this can only come about by education and a spirit of hopefulness among the workers. Good feeling on both sides and a recognition that the present movement is certain to be of a permanent nature are needed to make the period of transition to a new state of things as little uncomfortable as possible. The Greek poet who said that a city is made of men not of empty ships and walls would have added, had he lived today, or of empty factories.

Lastly there is the question of money, and its availability for industries; with which should be considered the question of Government organisation for assistance to industries.

There is not enough available capital in the province to finance any rapid expansion in its industries. Agriculture requires and can profitably employ, much more capital than it commands at present. Even such capital as exists is very reluctant to embark in new enterprises. There is, therefore, the choice between freely admitting outside capital, trusting to the increasing wealth which it will bring to enable you to buy it out gradually at a later stage, and sitting on the sources of raw material in the attempt to preserve them for local investors, on the ground that they will not run away and that

some time or other local capital will come forward to exploit them. Under the Reforms Scheme the decision of these questions will lie to an increasing degree in the hands of the people of the province. But in other countries similarly situated to India, foreign investors have been gradually bought out by local capital; and the same result should be anticipated here. To exclude outside enterprise, is to restrict the growth of intelligence, enterprise and wealth inside.

The best method of making capital locally available is undoubtedly the extension of banking facilities. This will enable money to circulate more rapidly and will also familiarise people with industrial and other forms of investment. Bankers can assist in many ways in the flotation of joint stock enterprises; and when a man is used to keeping his money in a bank, it is not a big step for him to invest some of it in industrial enterprises. The amalgamation of the Presidency Banks will accelerate the opening of new branches to a far greater extent, it may be hoped, than the 100 to which they are formally committed; other banks will follow suit; the activity of banking enterprise, which had a severe and quite unnecessary setback in 1913, will extend and increase. The problem of starting small rural banks was in a fair way of being solved but for the mistakes made at that time, and the solution is not likely to be much longer delayed.

Government patronage and support of industries is a useful help at present; but it cannot permanently maintain industries, and has led in many other countries to very unpleasant results in politics. But, at any rate, the institution of a stores purchasing department in India which will shortly come about will enable Government to place more of its orders with Indian manufacturers than hitherto and the officers of the department will naturally have to educate manufacturers to produce up to Government standard with a resulting increase of efficiency. For the present, loans on lines similar to takavi, guaranteed orders, guarantees of interest on capital in special cases, are means of encouraging nascent industries, which are, or shortly will be, at the disposal of provincial Governments. But these artificial methods should be so applied as to be readily replaced by the ordinary financial facilities of commerce when banks are available in sufficient strength to do the business which they can do far better than Government.

The provision of competent and disinterested technical advice by Government is also a potent means of encouraging the investment

of capital in industries. But to render this available to large and small industrialists alike needs a somewhat extensive organisation, both in the districts, at provincial headquarters, and with the central Government. Though there is much to be done before a complete system is evolved, the general lines are fairly clear. The provincial Governments have, practically speaking, a free hand, subject to the limitations imposed by their own financial resources. The Government of India will supply experts who have to work in teams, *e.g.*, for glass manufacture investigations; or who are needed by several provinces, but would not have work enough in any one. The needs of the small industrialist must not be overlooked. He must have within easy access some one able and willing to tell him how to get the machinery he wants, how to erect it and how to keep it up to the mark and repair it, if it goes wrong. I have seen some shocking instances of waste in the Central Provinces, owing to the bad upkeep of small power plant. The cottage worker should also have improved methods worked out and explained to him. The Government require business advice on the industrial problems, which will be brought before them in increasing numbers as the province develops. All these needs can only be met by a properly organised department consisting of specialists, helped by the advice of local business men and financiers; and this department will doubtless control technical and industrial education and be responsible for the administration of laws relating to machinery and the protection of labour.

Industrial improvement has however much more than a merely economic value. Familiarity with modern technical appliances and economic systems broadens the mind and develops the faculties of the people and makes them fitter for political responsibility and for progress. Mere political advance, unaccompanied by the equipment of civilization, is absurd and dangerous. No nation can command the respect of its neighbours, or secure the safety of its citizens, that does not fully develop its resources of raw material and possess an industrial equipment on a par with that of the rest of the world. We have seen how India fared in war time; it is a country that can make textile articles, but not the mill machinery required to make them; that can work railways to carry off her raw materials for other countries to consume or manufacture, but cannot make a locomotive to run on them; that cannot make a motor car, or a steel plate, or an aeroplane. India cannot take the position of a

great country, whatever her political status, as long as her people are unable to equip themselves as a modern nation must be equipped whether for peace or war. The strongest economic and military reasons exist for our making the most of the materials which have been placed ready to our hands. They have been put there for us to use; but their use has not been made too easy, in order to call forth the qualities of energy, skill and inventiveness that every nation possesses, and in which I am convinced that India is not deficient.

C. E. LOW.

WELFARE WORK IN BOMBAY COTTON MILLS.

BY

N. M. JOSHI, M.L.A., B.A.

With the object of introducing welfare work in the industrial undertakings in Bombay on a systematic basis, the Social Service League, Bombay, approached, nearly three years ago, some of the mill-owners with a scheme of welfare work. In accordance with the scheme the League was able to start the Currimbhoy Ebrahim Workmen's Institute which was soon after followed by the Tata Sons Workmen's Institute. These two institutes carry on welfare activities for the operatives employed in the two groups of mills under the agencies of Messrs. Currimbhoy Ebrahim and Sons and Messrs. Tata Sons, respectively, under the League's supervision. Welfare work being in a large measure of the same nature as social work which the League has been carrying on for a number of years it was in a position to provide guidance and also to train workers in that special line. Welfare work, to be thoroughly effective, must have a definite integral place in industrial organisation. At present very few employers of labour in this country realise the importance of welfare work and the benefits accruing from it, not only to labour, but also to themselves as a class and to the general community. Not a few employers look upon this work as a fad, an attitude adopted by the same class of men in England only a few years ago. Welfare work is no doubt primarily concerned with the human side of industry, but it is not solely of the humanitarian nature. Those who have tried it in a scientific manner have found it also a sound business proposition. Most of our capitalists have not, however, found time to keep themselves abreast of the developments that have taken place in England and America so far as this aspect of industrial organisation is concerned, and even those few captains of industry who favour the idea of introducing this kind of work in their mills and factories have, as a rule, very little time to devote to the preparation of various schemes of that work in detail. If the execution of such schemes is entrusted to a manager of a cotton spinning and weaving mill who has already his hands full

and cannot be expected to give attention to detail, its success may well be doubted. Moreover, the officials, even those who are not illiberal in their views regarding the treatment of labour, are bound to be conservative in their attitude at least towards certain items and methods of welfare work as they have been accustomed only to look for immediate results in production. A welfare worker must serve as a link between employers and employees and through his instrumentality the human touch has to be established between them. This can be done by him only if, instead of assuming the role of a hide bound official, he is able to take long views of the labour problem in general and keeps himself well posted in the knowledge of welfare activities undertaken elsewhere. It goes without saying that he must be able to bring to bear a fresh and wide outlook on the relations between employers and employees, so that he must have an aptitude for social work and be tactful in dealing with both the parties, *viz.*, the managing staff and the workpeople. Hence the necessity and desirability of having an institution that can supply welfare workers, well-grounded in principles of and trained in, their work. The Social Service League is fulfilling the function of such an organisation, at present, so far as some of the Bombay Mills are concerned.

Some of the Welfare Activities.

In England the earliest definite schemes of welfare work were associated with firms engaged in the manufacture of cocoa, soap, tobacco, box-making, etc., and the cotton industry was the last to join in the movement. The cotton weaving and spinning industry, which is the most important of Bombay's staple industries has been the first, so to speak, in that field in this country. Welfare work in the textile mills of Bombay has its special problems, and a wholesale introduction of the welfare activities that have proved popular and successful in England is likely to be attended with much waste or utter failure.

Co-operative Credit Societies form an important feature of our work in Bombay, the millhands as a class being thriftless and consequently heavily indebted. The Marwari and Pathan money-lenders who ply their trade in mill localities charge interest on an average at the rate of one and four annas per month, per rupee respectively and on account of this usurious rate of interest those who once get

into the clutches of the money-lenders are seldom able to get rid of them. For the unfortunate victim of a Marwari and especially of a Pathan goes on paying interest for years, and as what he can spare from his wages after defraying the usual expenses is absorbed by this, he rarely, if ever, finds himself in a position to pay the principal amount and hence the necessity of providing means of cheap credit. The credit societies that have been formed in mills under the League's supervision are run on co-operative lines. These are financed by the mill agents, the share capital subscribed by the workmen being usually insufficient to meet the demands for loans. Each large department of a mill has its own co-operative credit society and smaller departments are grouped together according to their affinities, for this purpose. Almost all of these societies are in a sound condition and some of them have a large membership. The total membership of all these societies at present stands at about 2,500, their total amount of capital being Rs. 55,000 out of which Rs. 25,000 form the share capital subscribed by the workmen themselves. This is one of the most popular activities in our welfare work. To supplement the work done by the co-operative credit societies and to encourage thrift among the millhands by providing facilities for saving quite near at hand, it is proposed to start Mill Savings Banks, and one such bank is to be started shortly at one of the mills under the agency of Messrs. Tata and Sons.

There are also three co-operative stores and two cheap grain shops, established for the sale of grains and cloth. But they are not well patronised by the workers. In the first place the need for them in a city like Bombay is not very great and secondly, the Marwari or the Bania offers greater credit facilities and tempts the custom. Thirdly, the jobbers who even to-day have much hold over their workers act in many cases as commission agents to the Banias. The fent shops † where prices of cloth are much lower than in the market are, however, very popular.

The education of half-time workers is another important item in our programme. In addition to the three R's the half-timers are taught drill, music and drawing and there are sewing classes for girls among them. Fresh Air Excursions of the students of the half-timers' schools are arranged from time to time and they are also encouraged to have their own clubs to organise picnic parties and

† *i.e.*, shops where remnants of lengths are sold.

socials, the expenses of which are partly paid by them out of the subscriptions raised among themselves and partly by their Welfare Institute. There are also night schools for adult Workers. The total number of half-time boys who take advantage of the day schools is 600. A monthly bonus of either one rupee or eight annas is given to each boy attending the classes according to his regularity of attendance. Regular attendance is also helped by the device of keeping the tickets of boys with the school master from whom they have to take it before they go to the mill. The number of adult workers who attend the night classes is 650. These classes are generally held in the buildings of Municipal day-schools in the neighbourhood of the mills. Free Reading Rooms and Libraries are provided at six different centres in the vicinity of the mills, but as the workers are generally illiterate they are only useful to clerks, jobbers and other officials.

Generally each mill has a dispensary which is attended by a qualified doctor at a stated period; and the compounder usually attends for the whole day. Enquiries are made about the absentees on account of illness and arrangements are made for visiting the patients in their homes by the Mill's doctors. Creches or day-nurseries are established at two centres for taking care, during the day time, of the babies of the women working in factories.

At the Currimbhoy Institute a small stage with curtains is provided for dramatics and clubs of clerks in the mills give, from time to time, performances which are very popular. The arrangement for recreation are not yet well developed. Unfortunately there is great difficulty in securing rooms as well as open spaces for this purpose. Besides these from time to time magic lantern demonstrations, public lectures, temperance meetings, sports and races, and social purity movements like the Holika Sammelan are arranged.

Difficulties in Work.

Thus there is some work to be done within the premises of the mills and some to be done without. In both we have to contend with difficulties. As regards our work within the mills it may be laid down that its success depends to a great extent on the sympathy and co-operation of managers and the heads of the various departments. Very few mill officials understand the real significance of welfare work. Most of them think that it is a matter of mere

benevolence on the part of the Agents and naturally a few of them also believe that the millhands may be unduly pampered through it. A welfare worker is thus treated with distrust and suspicion, and is considered more or less as an intruder whose presence and activities have to be tolerated simply because the agents have in an indiscreet mood of benevolence introduced the undesirable novelty of welfare work. It must, however, be admitted that some of the managers and officers are very sympathetic and their co-operation has proved to be of immense value in pushing on our work. Amongst the men also the walfare worker has to meet with certain difficulties, the most prominent of which is the illiteracy that prevails among them as a class. This difficulty is experienced in almost every welfare activity. Want of education prevents a number of workers from taking proper advantages of the activities started for their benefit. Handbills, leaflets, pamphlets, reading rooms and libraries are of very little use. Besides, there are agelong jobberies and corrupt practices which render the welfare worker's path not a smooth one. For instance, if co-operative stores are started among the millhands they have to struggle for their existence, because in many a mill there are some jobbers and forewomen (*Naikins*) who act as agents of certain traders and get commission for providing custom to them. Naturally these people are interested in keeping things as they are and do their best to deter the men and women under them from joining the co-operative store movement. The workmen and women who are the victims of these clever people would understand their own interests better were they not so illiterate and ignorant. Even in the case of co-operative societies which are on the whole going on so well, the same kind of difficulty is experienced in such departments of a mill as contain a headjobber who is in league with professional money-lenders and carries on the profession him f privately.

The work which has to be done out of the mills' premises is greatly hampered by the fact that very few mills have chawls for their workmen, whose homes are therefore scattered over a wide area. This difficulty will be partially solved when the housing schemes of various mills are carried out. All the same there will be still thousands of workmen residing in privately owned chawls and huts and for them welfare work can be carried on only if the millowners will put forth combined efforts and help the institutions that will undertake to do the work on their behalf on a locality basis.

Much of the misery of the millhands lot can be traced to the widespread habit of drink. The wages of the Bombay millhands are low in comparison with those of their western comrades and there are some classes of mill operatives who are really illpaid. But even the weavers and other better paid class of workers whose monthly incomes cannot be considered lower than those of the poorer middle class people have not as a class improved in their economic condition. A considerably large portion of their income is consumed in liquor and their standard of living is as low as it was before. No welfare work can counteract this evil to an appreciable degree. A radical change in the Abkari policy of the state can alone stop the evil. The same applies to the problem of illiteracy. Education can be made universal only through a vigorous prosecution of the free and compulsory education policy. Very few adults take advantage of the night schools, and the attendance is always fluctuating. Each student on an average attends the school for not more than six months and then leaves it for good. Obviously this is too short a period in which to learn anything more than mere reading and writing. In the half-timers' day schools the attendance is not so irregular but there too what education is received by a boy or girl is hardly enough to be of much use in after life. After a year or so the half-timer becomes a full-time worker and then his education stops. When a boy of fifteen or a little less, however robust in health, has to work for ten hours, he naturally feels 'fed up' at the fag-end of the day and has little inclination to attend a night school. And girls' night schools are quite out of the question. The physical and mental development of young workers must always have a prominent place in welfare work, for the future of the industry depends upon them to a considerable extent. An experiment in establishing an eye and teeth clinic for half-time workers is being tried in one of the Tata mills. In the event of its proving successful the system will be extended to all other mills.

We have to feel our way in starting some new activities as certain types of welfare activities give rise to prejudices and misapprehensions, both the mill officials and workmen being more or less conservative in their views and habits. When we started our first creche the minds of the mothers working in the mill where it was to be opened had to be prepared to take advantage of it, for it seemed that most of the women thought that it was to be a kind of hospital and a "hospital" was associated with certain imaginary terrors in their

minds. This creche began with a small number of babies but became popular among the mothers in the mill with a short time. It was followed by another creche for a group of mills under a different agency and the women workers in that locality having become familiar with the idea no persuasion had to be used.

Conditions Essential to Success.

Welfare work is popularly associated with recreation, dining halls and such other things which really speaking, form but a fraction of the work which requires to be done for the benefit of workmen in an industry. Recreation and facilities in such other matters will help very little to improve the *morale* of the workpeople if they are ill-paid, ill-fed and ill-housed. The aim of welfare work must be to give such a turn to industrial organisation as will make the workpeople healthy, efficient, contented and happy, both in and out of the works. It must raise the standard of their living, improve the tone of their morals inside as well as outside the works and create a works *esprit de corps* among them. Welfare work presupposes certain conditions and they may be summed up as follows:—In addition to living wages there must be stability of employment, rules of service, discipline, etc., applicable to the whole factory and not left to the caprice of individuals; guarantee of a square deal; schemes of training apprentices, promotion of deserving workers to higher and responsible positions, provision of facilities for technical instruction, and rewarding good conduct, regularity, steadiness and skill among the workpeople; a ready machinery for removing grievances of the operatives, and encouragement to initiative among the workers themselves by all possible means. These are some of the things without which no welfare work can be successful in attaining its objects. We have made suggestions on these lines to the Agents on whose behalf we are carrying on welfare work, and some of those suggestions have, I may mention with great pleasure, been accepted by them. Rules for compensation in cases of accidental injuries to workmen, maternity allowance, sick benefit fund and works committees are among the reforms which have been approved.

Neglect of Humanics.

There is a tendency among a certain class of employers to regard their duty to their operatives as limited to the fulfilment of

the conditions imposed by the Indian Factories Act. This Act is admittedly defective in several directions. Even when it is properly amended it will only provide the minimum and welfare work will still be necessary. State legislation in such matters is always progressive and its progress is directed by the experiments made by individual factory owners for the benefit of their operatives as well as of their concerns. The efforts of such enterprising and far-seeing industrialists have contributed not a little to the progress of factory legislation in England. Many of our employers are quick to follow and to adapt the rapid developments that are taking place in countries more advanced industrially. It is among men of enterprise, foresight and uptodateness that welfare work finds its readiest response. But some employers are still content to conduct their businesses on the old orthodox lines and if an employer is reluctant to take advantage of labour-saving devices and of other improvements which conduce directly to his benefit, it is only natural that as regards welfare work, the benefits of which are not so immediately apparent, he should be equally conservative.

Not to speak of humanitarian motives, employers who take an enlightened view of their own interests, and, looking a little beyond to-day, take up the question of industrial organisation in a truly scientific and business-like spirit, find that the superficially cheap labour is very costly in the long run and that their aim must be to make their workpeople healthier, happier and more intelligent and more self-respecting. This last quality is absolutely essential. A really self-respecting workman will always be a safer person to deal with than one who is wanting in this quality. Particularly in welfare work it is necessary to preserve and promote self-respect, for if that work is carried on in a patronising spirit and is considered as only a sop, it is likely to lose all its value and labour will rightly resent it, when it will be sufficiently organised and class-conscious. It will be in the interests of the industry in general and no less in those of capital to anticipate intelligently the developments in the Indian labour movement. Those who hold the destiny of the industry in this country in their hands must, to safeguard its future, lend a helping hand in laying the foundation of an intelligent democracy.

N. M. JOSHI.

RESEARCHES IN TANNING AND THE CALCUTTA RESEARCH TANNERY.

BY

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1. Tanning an Ancient Art.

Tanning is one of the most ancient of arts, having been practised even by the primitive races long before the dawn of modern science. It has developed through ages of practice and most of the modern methods of leather production are results of thousands of years of experience. It is not much to be wondered at therefore, that tanners throughout the world have so obstinately clung to those old traditional methods.

2. Development of Modern Tanning in the West.

Modern science which has revolutionised so many arts and industries has been slow in making its influence felt in the art of leather manufacture, both because of the traditional conservatism of the tanners, and on account of the inherent difficulties of the subject. Tanning has to deal with complex materials and involves phenomena which are also very complex. Some of these latter have hardly been adequately explained even by the most advanced scientific discoveries of the present time. This is a case where "science must follow before it can lead" and consequently the early attempts of leather chemists were directed towards the understanding of the principles underlying the old methods. From the knowledge thus gained scientific methods of controlling the various processes have gradually been worked out and in comparatively recent times not only have decided improvements been made in several old methods but some entirely new processes of tanning (*e.g.*, chrome tanning, formaldehyde tanning) have been discovered by the votaries of leather chemistry. It can now be said that tanning is well within the chemist's control and further researches will ultimately transform this time-honoured empirical art into a

chemical industry. The need of research in tanning has been recognised in all civilised countries. In most of these tanning research institutes have been established during the last three decades. The success of the American and European leather trades is due in no small degree to the scientific work carried out in the various research institutes and wisely availed of and amply profited by in practice. Science has come to stay in tanning and those who desire to be in the van-guard of the industry must seek its aid. Happily most western tanners have realised it.

3. Tanning should be developed in India.

The history of the development of modern tanning in the West is full of instruction for tanners in India. Leather industries are still at a very low stage of development in this country, but in consideration of its rich resources of hides and skins and of available tanning materials, it is now recognised that tanning should be developed here. The Industrial Commission also laid particular stress on tanning and there was ample justification for it.

India is one of the biggest hide producing countries in the world. There are estimated to be 180 million cattle and 87 million goat and sheep in India and she produces annually, at a rough estimate, taking the pre-war price of 1913-14, about 16 crores of rupees worth of cow hide and 4 crores of rupees worth of goat skins. Besides cow hides and goat skins she produces also a considerable quantity of buffalo hides, which are suitable for making leathers for cheap soles, belting, picking bands and loom pickers. She has also quite an abundant supply of sheep skins.

In the absence of an organised tanning industry in India, the bulk of these hides ("at least half of the hides and $\frac{9}{10}$th of the skins") are exported abroad. Before the war a considerable quantity of cow hides (about 64 per cent. of the total exports) used to go to Germany and Austria, while America used to take about 73 per cent. of the total exports in goat skins and is even now taking the bulk of the Indian goat skins.

4. Suitability of Indian Hides and Skins for making High Class Leather.

The German tanners used to tan the best of the Indian cow hides by chrome process and finish into box sides, which as cheap substitutes of box-calf found favour in the European leather

trade. It is well known that the American tanners make their best *glacé*-kid from the Indian goat skins.

It has thus been established that very high class leather can be turned out from the Indian raw materials if they are treated in the right way, and the first problem before the pioneers of tanning in India is to find out the proper method which would transform the available hides and skins into as good leather as is produced from them in Europe and America.

5. How to develop Tanning in India.

This is by no means an easy task. A mere transplantation of the western methods to the Indian soil will not be effective. They must be altered and modified to suit local climatic conditions. Many processes in tanning involve chemical and bacterial actions which are greatly influenced by temperature; hence working conditions suitable in colder climates will, in most cases, be found unsatisfactory in the tropical climate of India.

For this reason therefore, although rough outlines of modern tanning methods may be obtained from the West, the detailed processes must be locally worked out by systematic research in order to obtain the desirable result.

Investigations in the laboratory alone will not be sufficient. Practical tanning experiments on as large a scale as practicable must be conducted in experimental tanneries. This work should be done by experienced tanners who have at the same time a sound knowledge of chemistry and bacteriology.

The Indian tanning trade is still entirely in the hands of an illiterate and depressed class, the chamars. Although some of them are skilled workers it is idle to expect that they will ever grasp the scientific principles of tanning or will be able to supply science to the art, a thing which is essential for the development of tanning in India. If leather manufacture is to be improved in this country the industry must be placed in the hands of people having scientific training and the recruits for training as tanners must be drawn from the science graduates of the Indian Universities.

6. The Object of the Establishment of the Calcutta Research Tannery.

With the object of fostering the growth of tanning the Government of Bengal established the Calcutta Research Tannery in 1919.

The institute consists of (*i*) a chemical laboratory, (*ii*) a bacteriological laboratory and (*iii*) a demonstration tannery.

(*i*) *Chemical laboratory.*—The programme of the chemical laboratory is as follows:—

(*a*) Analytical control of the various tanning operations.

(*b*) Analysis of vegetable tanstuffs and other tanning materials for the trade, with or without fee as the case may be.

(*c*) Investigations of local tanning materials with a view to fixing their commercial standards of strength and to finding out the most economic methods of their utilisation.

(*d*) Examination of various forest products for the purpose of adding to the present stock of Indian tanning materials by fresh finds.

(*e*) Original researches to investigate the still unsolved problems of the applied chemistry of leather manufacture.

(*ii*) *Bacteriological laboratory.*—Many tanning operations involve bacterial action, hence the chief objects of the bacteriological laboratory are (*a*) to control such operations and (*b*) to find out by research, enzyme or bacterial products of standard strength and known constituents which might replace the obnoxious animal excreta which are still used for puering and bating and whose actions, though efficient, are sometimes difficult to control.

(*iii*) *The Demonstration Tannery.*—In the demonstration tannery practical tanning experiments are carried out with a view to working out methods suitable to local conditions for the production of such leathers from local hides and skins as are made from them in Europe and America.

7. Equipment of the Institute.

For all the work briefly indicated above the Research Tannery has been adequately equipped. There are four separate blocks (see plans, facing page 40) built on a picturesque site on the Beliaghata Canal. The compound consisting of about 4 acres of land has been walled up. Block I consists of the laboratories, the

office and the Superintendent's room. Block II is the demonstration tannery. Block III consists of the tanstuff crushing room and crushed tanstuff store. In block IV are the lime, raw-hide and and crude tanstuff godowns. A tank has been excavated in the compound to supply water to the tannery. There is also the Calcutta Corporation filtered water supply, which is used in the laboratory and also in such operations in the tannery for which a clear soft water is required. There is supply of gas in the laboratory and the tannery, and the place is lighted by electricity. It was originally intended to run the plant by electric power, but as sufficient current was not available that project has fallen through, and a 19 Horse Power Oil Engine has been fixed up. A boiler is also going to be installed for the supply of steam which is necessary for heating various baths in connection with the tanning operations. The chemical laboratory has been divided into two sections. One general laboratory, a room 49′—10′×15′, has been fitted with four double working benches where 16 men can work at the same time. This is used by the junior assistants and apprentices for routine work. Another room, 20′×15′, fitted with one double and one single working bench, has been kept for higher research work and is used by the Chemist in charge. The balance room is situated between the general and research laboratories so that it is accessible to and used by both.

The bacteriological laboratory has been fitted with one working bench and a few tables for microscopes.

The Demonstration tannery has been equipped for both vegetable and chrome tanning.

There are 12 lime pits, 20 large and 8 small tanpits together with a well for liquor. One rolling machine for sole leather is being fitted up.

For chrome tanning, the arrangement is two large and two small drums, two paddles, one staking, one glazing and one shaving machine.

On account of the abnormal industrial conditions in England there was considerable delay in getting out the machinery. They have, however, all arrived and are now in course of erection.

8. The Management and Staff.

The institute is under the Director of Industries, Bengal, assisted by a Board of Directors of which he is the Chairman. The directors

are all men interested in the tanning industry in Bengal. The staff consists of the Superintendent, the Research Chemist, one assistant chemist, a foreman tanner and four paid apprentices. Besides these, eight volunteer (non-paid) apprentices have been taken in for training. All the apprentices with one exception are matriculates, four being graduates. Of the four paid apprentices two are graduates receiving a monthly stipend of Rs. 30 each and two under-graduates getting Rs. 20 each. The apprentices do the manual work in connection with the various tanning operations in order to obtain a good first hand knowledge of the working details.

9. Work done so far.

The Research Tannery was officially opened on 1st May 1919, but on account of the unavoidable delay in the appointment of staff, in getting supplies of special chemicals and apparatus most of which had to be indented for from England, regular work could not be started before September 1919. Some important laboratory apparatus has not been received as yet.

Hence only those investigations which could be carried out with locally available chemicals and apparatus were at first undertaken.

10. Investigation on Goran.

Of the local vegetable tanstuffs goran (Ceriops Roxburghiana) was selected as having prior claim for investigation, not only on account of its being one of the richest in tannin content (about 30 per cent. tannin) but also because it is the least investigated and most deprecated of all local tanning materials.

If its objectionable features can be eliminated by close investigation, it may prove immensely useful to the local tanning industry. Experiments have therefore been planned both at the laboratory and the tannery to attain this end.

A good deal of work has already been done to find the optimum conditions for its extraction.

11. Investigation on Chrome Liquor.

Investigation on chrome liquors have also been undertaken and a special study of the influence of sodium chloride (often added by practical tanners to chrome tanning liquors) on one bath liquor has been made. The work was done by the Research Chemist,

Mr. B. B. Dhavale, M.A., and the Assistant Chemist, Mr. S. R. Das, M.Sc., and the paper has been published in the journal of the Society of Leather Trades Chemists, the official organ of the European leather chemists.* The conclusions arrived at are (1) that the addition of sodium chloride up to a certain limit increases the acidity of chrome liquor and (2) that beyond that limit the addition has no further influence. Hence it is advantageous to add sodium chloride to one bath chrome liquors in the early stage of tannage, as it allows more basic liquor to be used without causing drawn grain.

12. Investigation on Tannery Waters.

The water supply is a matter of great importance in a tannery, as the quality of the tannage is much influenced by the water that is used in making up the various tanning baths. To obtain information regarding the characteristics of the waters of various tanning districts in India, a survey of the Indian tannery waters is being made. Samples of water from most of the well-known tanneries and tanning districts of India have been analysed and the results, which are very interesting and which, it is hoped, will be very useful to the Indian tanners will shortly be published in the form of a pamphlet.

13. Enquiries from the Trade.

Many enquiries have been received from tanneries and those interested in tanning and several analyses of tanstuffs, tanners' sundries and leather have been made for the trade. Investigations with a view to solving specific difficulties of a local tannery were undertaken and much technical assistance was rendered to the tannery in question. A few technical enquiries received from provinces outside Bengal have also been responded to.

14. Control Work.

Regarding analytical works for controlling the various tanning operations stress has been laid on the following :—

(*i*) Determination of the acidity of tan liquors.

(*ii*) Study of the speed of tannage.

* See pages 107—109.

(*iii*) Determination of the basicities of chrome liquors which are used for tanning.

(*iv*) Analyses of the resulting leathers.

(*i*) *Determination of acidity of tan liquors.*—In vegetable tannage the nature of the final leather is much influenced by the acidity of the tan liquor. The acids are formed in the liquors by the fermentation of sugary and starchy matters which are always associated with the tannin in vegetable tanstuffs. Different tanstuffs produce different amounts of acid, depending upon the percentage of fermentable carbohydrates present in them. Temperature has a great influence on the vigour with which fermentation proceeds and consequently on the quantity of acid produced in the liquor. It is therefore to be expected that in tropical countries like India, a liquor made from a given material will turn sourer in a shorter time than would the same liquor in colder countries. Consequently, if the control of the acidity be important in European and American tanneries, it is even more so in India for uniform and satisfactory tannage.

Generally it may be said that sour liquors are beneficial in the early stages of tanning, but the degree must depend upon the qualities desired in the final product. Hides for sole leather are better treated at the outset in fairly sour liquor, but those for soft and supple upper leathers require liquors of much less acidity. The reason for this is obvious Acids cause swelling of the pelt and as sole leather has to be thick, the action of acid is beneficial. Further, leather tanned in the swollen condition becomes stiffer and stiffness is also a quality desired in sole leather. As a matter of fact it has been found of advantage, in sole leather tanning, not to allow the lime swollen pelt to deplete by deliming, as is done with other classes of leathers, but to take them at once to weak sour tan liquors in which the deliming is effected gradually by the acids present, keeping the hides swollen all the time. The alkaline swelling due to lime is thus gradually replaced by the acid swelling of the liquor. In upper and dressing leathers on the other hand where softness and flexibility are desiderata, the swelling has to be checked.

On account of the important part that acidity of tan liquors plays in the tannage, a systematic testing of the working liquors of the Research Tannery is being done. The acidity has been determined by the "Procter's lime water method." The results arrived at clearly show that at the temperature that obtains in

Calcutta the acidities vary within the wide limits and liquors have been found having an acidity so high as 862 c.c.N/10 acid per litre. The acidity usually increases with the age of the liquor. For satisfactory tannage some way must be found for controlling the variations of acidity, and an investigation with that object in view has been undertaken at the Research Tannery.

(*ii*) *Study of the speed of tannage.*—In connection with the experiments on sole leather manufacture the progress of tannage is being determined by the analysis of samples cut from a piece of hide under tanning at regular intervals. As the tannage progresses the amount of tannin absorbed increases. Thus the determination of the absorbed tannin measures the speed of tannage. Several determinations at intervals of one week have been made.

(*iii*) *Determination of the basicities of chrome liquor.*—The determination of the basicity of chrome liquors is of great importance to chrome tanners, as it is the basicity which to a large extent determines the quality of the tannage. Too basic liquor will draw the grain and in extreme cases may even lead to case hardening. Too acid liquor swells the fibres and produces light tannage while if the basicity exceeds a certain limit the liquor will not tan at all. Different classes of leathers require liquors of different degrees of basicity for satisfactory tannage, that is to say, other conditions remaining same, there is an "optimum" basicity for each class of leather.

In India chrome tanners have been making their liquors according to the recipes prescribed in Europe mostly for calf skins. These answer well for calf skins and also fairly well for the Indian kips. But it is still a subject for investigation whether the basicity obtained according to these recipes is the "optimum" for East Indian kips.

To study this problem the basicities of a few chrome liquors which are used in practical tanneries were determined. The result of one typical sample made from bichromate of soda, sulphuric acid and cane sugar is as follows :—

$$\left.\begin{array}{l} Cr''' : SO_4'' = 52 : 102{\cdot}4 \\ Cr''' : SO_4'' = 52 : 103{\cdot}9 \end{array}\right\} \text{Duplicate.}$$

Liquor of this basicity is giving satisfactory results.

The liquors used at the Research Tannery are always tested for their basicities and these have been found to vary between 52/79·4 and 52/92·3.

(iv) *Analyses of leathers tanned at the Research Tannery.*—Samples from several lots of *glacé*-kid and box sides turned out at the Research Tannery have been analysed with a view to finding the amounts of chrome, fat, hide-substance and moisture present in the leather and as the final quality of leather is determined by these factors their quantitative determination would serve as good guides in modifying experiments so as to get the desirable result.

To illustrate the point the comparative analytical figures of a sample of box kip of Indian manufacture and one of English box calf of standard quality which were analysed at the Research Tannery may be cited.

—	English box calf	Local box-kip.
	per cent	per cent
Moisture	14·4	13·8
Ash	4·0	5·5
Chromium (as Cr)	2·12	3·25
Fat	9·1	6·3
Nitrogen	12·3	11·2
Hide-Substance	69·0	62·88

The English box calf from which the sample was cut for analysis was of very fine quality and worthy of imitation by the Indian chrome tanners. The box kip analysed was of average quality as usually made in Calcutta. From the above analyses it is to be noted that the local box kip is strikingly deficient in fat and also poorer in hide-substance than the English box-calf. This may be one cause of the inferior quality of the locally made leather in comparison with the English and American makes and as such deserves the attention of the local tanners. They should try to introduce more fat into the leather without making the surface, however, so greasy as to interfere with the glaze, and also to modify their liming and deliming processes so as to preserve more hide substance in the leather.

15. Work at the Demonstration Tannery.

In framing the programme of work for the demonstration tannery, the present condition of the tanning industry in Bengal and its immediate needs in the direction of improvement, were the chief deciding factors.

16. Present Condition of Tanning in Bengal.

The tanning industry in Bengal is practically represented by the tanneries in the neighbourhood of Calcutta. Excepting perhaps a dozen modern tanneries which are the outcome of the war, the rest, nearly 240 in number, are all of primitive type and very small. It has been estimated that the combined daily output of these small tanneries is 1,000 cow hides, 200 buffalo hides, 250 sheep and 100 calf skins. They employ about 1,500 men.

17. Description of a small Tannery.

A thatched or tiled hut, with a dozen pits and tubs equipped with a couple of unhairing and fleshing palm-tree beams usually forms a tannery of this class. The owners, mostly Muhammadans, do not trouble much about the technical side of the tannery and leave the manufacture entirely in the hands of mistries (chamar foremen). The mistry is usually illiterate and all the wealth of his technical knowledge consists in what has been handed down to him by his fore-fathers. Though he sometimes makes good leathers, his methods are at least half a century behind the times. The improvements that modern science has effected in the art of leather manufacture have had no chance of coming to his notice. His craft has been looked down upon from time immemorial and his caste in consequence is depressed. He has been denied the light of education as well as the lead and co-operation of his enlightened countrymen. It is not wonderful that he should have failed to improve his art, with the result that the tanning methods still used by him have been long discarded by the progressive tanners of the West. If the products of the small Indian tanner are to be raised to the modern standard of quality, his methods need a thorough overhauling; while the activities of the large scale tanneries recently started will require to be directed toward adapting the modern methods to local conditions at least for the first few years. Both these require sustained efforts and systematic research by practical tanners as well as leather chemists.

Tanning of cow hides has been locally practised for a long time, and the recent modern tanneries have also engaged themselves in this branch of leather manufacture. Tanning of buffalo hides for sole leather, and of goat skins for *glacé*-kid, have been neglected altogether.

The first activities of the Research Tannery were consequently directed towards working out of methods for the manufacture of sole leather from buffalo hides by using goran and other local tan-stuffs and of *glacé*-kid from local goat skins by the chrome process of tanning. Later on, attention has also been given to the improvement of the local methods of manufacture of box sides from cow hides.

18. Investigation on Sole Leather Manufacture.

Local buffalo hides and local tanning materials have been chosen for this investigation and particular attention has been given to the utilisation of goran in the tannage.

The chief qualities desired in good sole leather being firmness, solidity and weight all the operations from the selection of hides to the finishing of the tanned leather have been directed towards the attainment of these ends. The traditional methods of the chamar have been adopted wherever they were found good and have been discarded when found harmful. Thus the long liming which chamars usually give to the buffalo hides has been replaced by the short liming process with the help of sulphide of soda. The latter method, while preserving hide-substance, produces firm leather while the former dissolves out much of the hide, and makes the final leather porous, spongy and flabby. The usual chamar's process of deliming with fermented wheat bran has been adopted, as this is at once simple and cheap, and if the deliming is confined to the surface of the pelt only, the final leather has been found to be quite firm. The modern western method of deliming with lactic acid appears to be expensive, and comparative experiments have shown that it possesses no advantage over bran. The old process of bag tannage has been discarded as it seems impossible to make good leather by it. The country method of tanning throughout in layers has been found to be quite good, but is decidedly slow as compared with the modern western method of tanning in leached liquors. The latter method has therefore been followed. The country chamar never finishes his sole leather but simply dries it out after tannage. This deteriorates the quality of the leather and also decreases its cutting area. The sole leathers turned out at the Research Tannery are finished properly.

Quite a workable process for the manufacture of sole leather of good quality has now evolved from the experiments that have

been conducted at the Research Tannery. One hundred and forty-nine hides have already been tanned and at the auction sales by which the outputs of the tannery have been disposed of, some of the backs fetched as high a price as Rs. 1-6-6 per pound.

19. Investigation on the Manufacture of *Glacé*-kid.

The Bengal goat skins of the quality known in the trade as "Kusthias" have been chosen for these experiments. They are received at the tannery in the wet salted condition. A few dry salted skins have also been put through.

The chief difficulty in the manufacture of high class *glacé*-kid is the production of smooth grain. Goat skins are by nature harsh on the grain and from some breeds, for instance the heavy Amritsars, it is impossible to produce smooth grained leather. Hence for the production of high class *glacé*-kid suitable raw skins must first be selected. Much also depends on the operations that the skins have to pass through during tannage, the objects of all of which are the production of soft, smooth and highly glazed leather. The most important operation is perhaps the "puering" which is done after liming and prior to tanning. This operation mainly determines the softness of the final leather and smoothness of the grain.

The most efficient material for puering goat skins is the fermented infusion of dog-dung. This has been used for the purpose from time immemorial, and on account of its obnoxious character, attempts have of late been made to find a substitute. Although many artificial puers have been prepared and are on the market none seems as yet to be as efficient as the dung. In Europe and America the dung puer is freely used, but in India its use is extremely rare; this is probably due to the prejudice of the chamars against the material. It will take some time to overcome this prejudice.

Puering with dog-dung with certain modification has been introduced at the Research Tannery and the results obtained so far are satisfactory. Artificial puers are also being tried and their effects compared with those of the dung puer. As yet the latter appears to be superior.

Both one bath and two bath processes of chrome tanning were tried in the preliminary experiments; these show that the latter method (*viz.*, two bath process) is decidedly more suitable for *glacé*-kid manufacture. Hence subsequent experiments have all been carried out by the two bath process.

348 skins have been tanned and quite a number has been finished. Some of the finished leathers produced are of high quality and the results obtained so far are encouraging.

20. Investigation on the Manufacture of Box Sides from local Cow Hides.

Although the manufacture of box sides by the chrome process has made considerable progress in India during recent years, and several firms both in Bengal and in other provinces are engaged in this branch of leather industry, the products of nearly all of them suffer from one common defect, *viz.*, looseness of grain. This must be remedied before Indian box sides can successfully compete with foreign makes in the markets of the world.

The looseness is in some cases due, no doubt, to the inferior quality of the hides, but often to improper liming. "Leather is made or marred in the limes" is an old saying among the tanners; and the truth of this cannot be too strongly emphasised.

Experiments with cow hides have been started with a view to improving the method of liming for the manufacture of box sides. Limes sharpened with sulphide of soda are being tried.

In one experiment a pack was limed for three days only in strong sulphide lime, in another for six days with less sulphide and in a third the hides were painted with a thick paste of lime and sodium sulphide (10 : 4), were unhaired after three days and plumped up in fresh limes for a further three days.

Of the three methods tried, the second, *viz.*, six days liming, has so far produced the best result. Hence several lots have been put through to give it a thorough trial and the leathers obtained seem to be decided improvements and have been sold at good prices at the auctions.

21. Training of Apprentices.

Besides investigation and research the institute is also training apprentices within the limit of its accommodation. Twelve apprentices are now under training. Two science graduates have already been trained as leather chemists and ten are being trained as practical tanners. One apprentice after a year's practical training at the Research Tannery has received a situation as assistant tanner in a tannery near Calcutta. The need of trained assistants for the

leather trade in India may be judged from the many enquiries the Superintendent receives from the employers for such assistants. The Indian youths also seem very eager to learn tanning, as is evidenced by the number of applications constantly flowing in for apprenticeship in the Calcutta Research Tannery.

22. Conclusion.

As has already been said the chief object of the Calcutta Research Tannery is to foster the growth of tanning in this country, as the several tanning research institutes have done in Europe and America. No industry can thrive in modern time unless its science and practice are combined, and this combination is the principal aim of the Calcutta Research Tannery.

It is trying to put the old indigenous rule of thumb methods on a sound scientific basis. At the same time attempts are being made to pioneer the manufacture of such varieties of leathers from Indian raw materials as have not yet been successfully made in this country, and of which private enterprise naturally fights shy, at the absence of a prospect of immediate profit.

Scientific investigations are being carried out side by side with practical training experiments. Chemists and tanners are co-operating with the common object of advancing the industry. As a resort for technical advice and a place of reference for tanning problems, the Calcutta Research Tannery has already attracted the attention of tanners of Bengal as well as of other provinces. It may thus be expected that in course of time it will prove of immense utility to the growing leather industries of the country and will amply justify its existence.

B. M. DAS.

PLANS.

General plan of the tannery compound.
Plan of the laboratory and office.
Plan of the demonstration tannery.

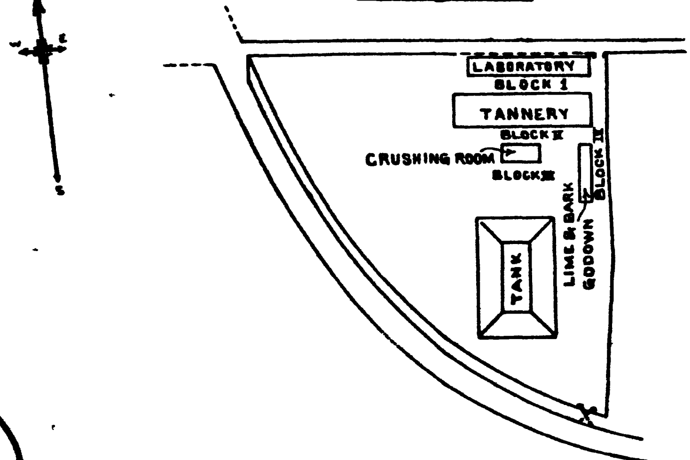
PLATES.

1.—View of the Calcutta Research Tannery from the other side of the canal
II.—The tan-yard.
III.—The lime-yard.
IV.—The general laboratory.

BLOCK PLAN

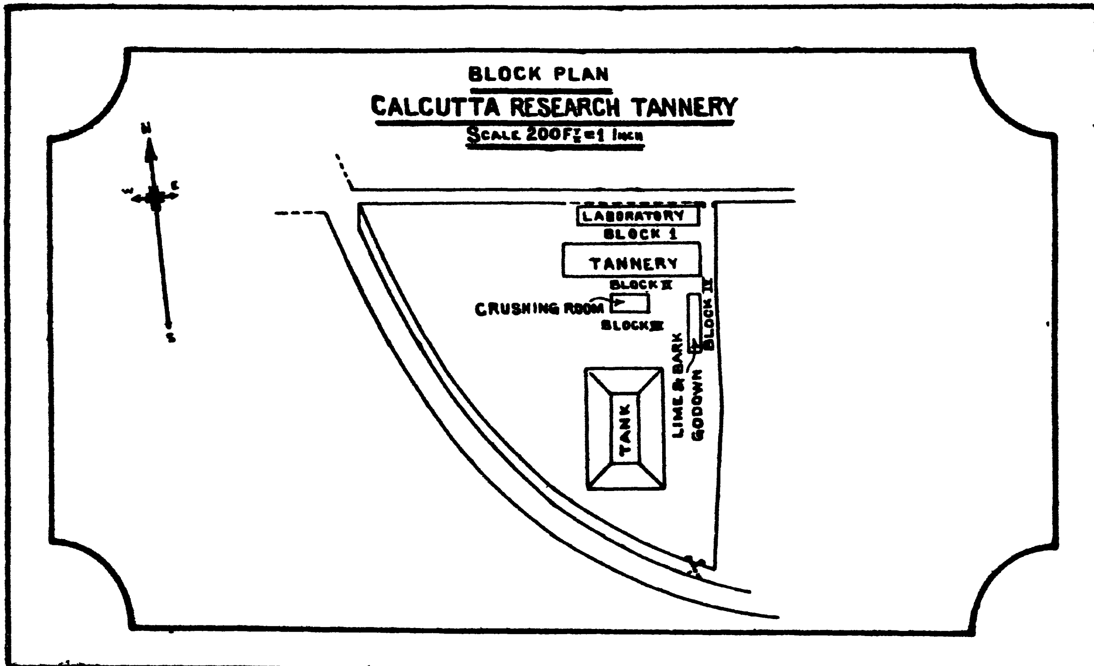
CALCUTTA RESEARCH TANNERY

SCALE 200 FT = 1 INCH



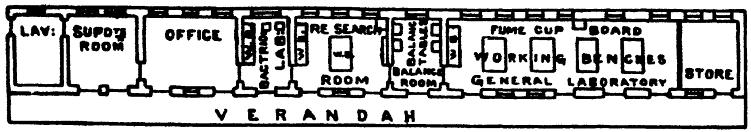
PLANS.

PLATES.


BLOCK PLAN
CALCUTTA RESEARCH TANNERY
SCALE 200 FT = 1 INCH
LABORATORY
BLOCK 1
TANNERY
CRUSHING ROOM
LIME & BARK
GODOWN
TANK
N
S
E
W

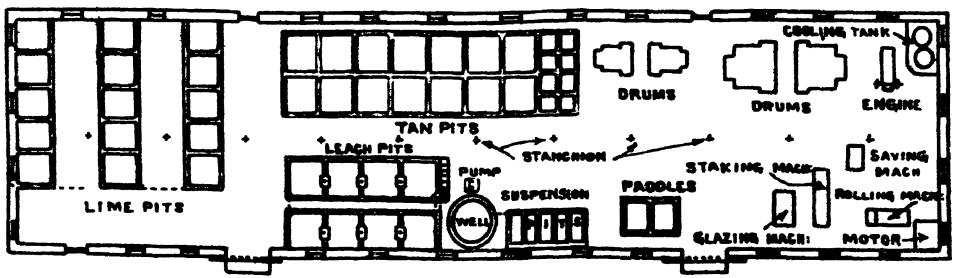
TANNING RESEARCH LABORATORY

Scale 32 Ft = 1 Inch



THE DEMONSTRATION TANNERY

Scale 32 Ft = 1 Inch



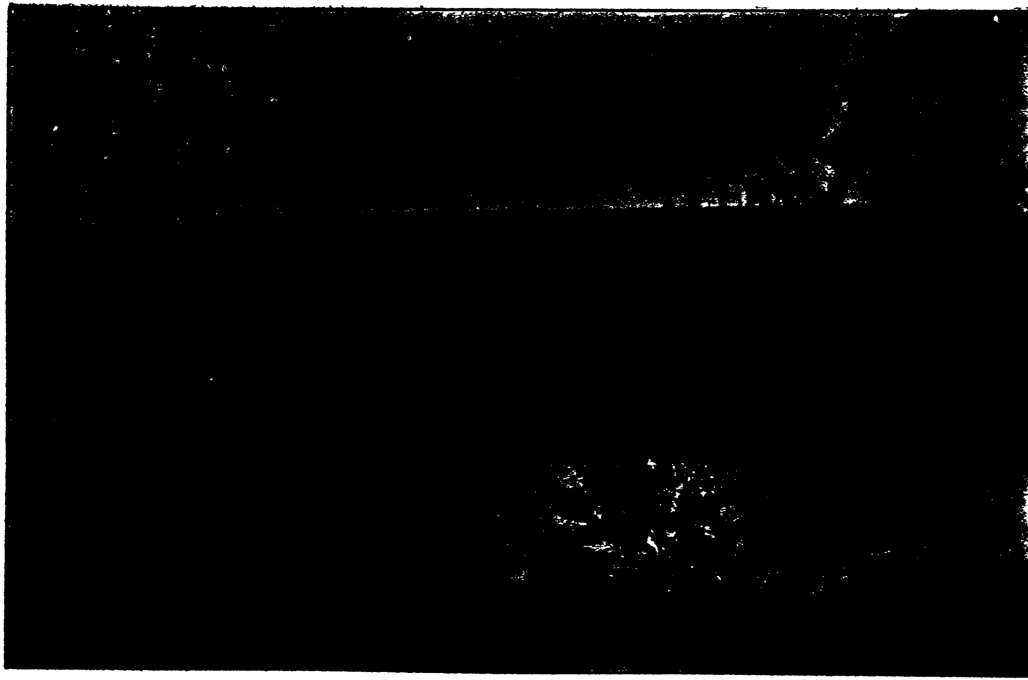
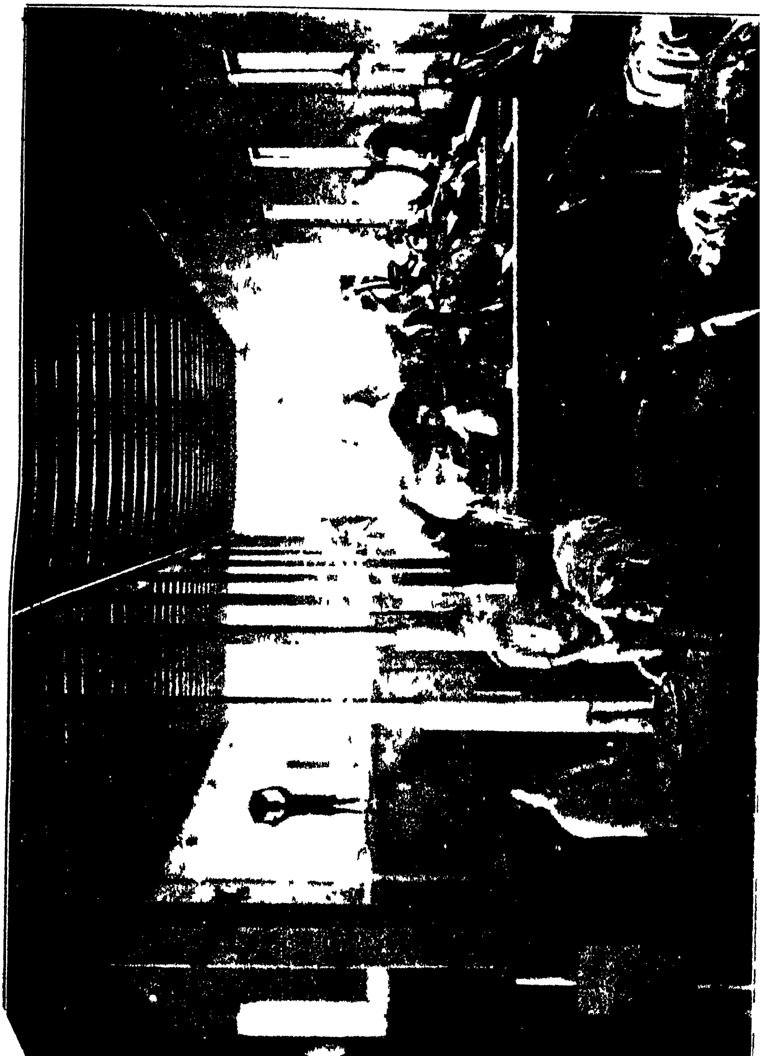
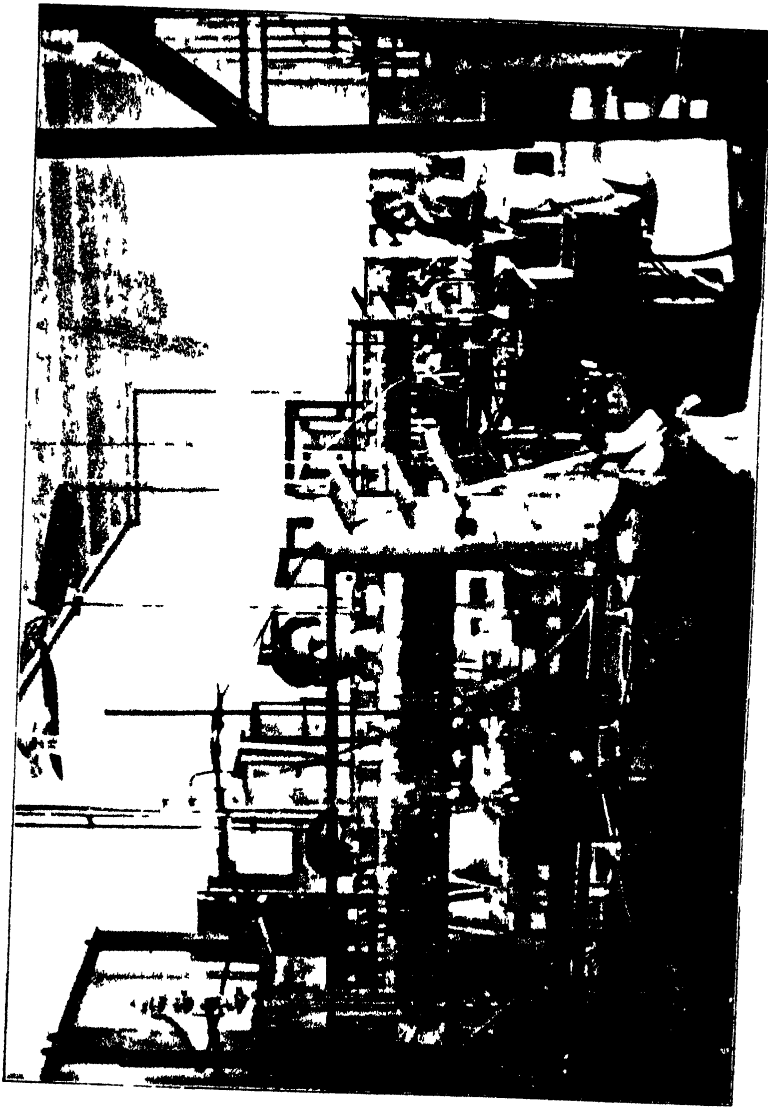


PLATE I. VIEW OF THE CALCUTTA RESEARCH TANNERY FROM THE OTHER SIDE OF THE CANAL





CLOVE OIL FROM CLOVE STEMS.

BY

S. T. GADRE, M.A., A.I.I.Sc.,

Industrial Chemist to Government, United Provinces, Cawnpore.

Africa is the home of cloves and most of the world's supply of this commodity comes from Zanzibar and Pemba. It is estimated that there are in both the islands about 52,000 acres under clove cultivation and about 4,700,000 trees in bearing. The large plantations are chiefly owned by the Arabs, a few being owned by Indians.

So far as recorded information is available, the clove industry dates from 1818; but, in the year 1872, when the output had reached 7,000,000 lbs. a year the plantations in Zanzibar were devastated by a hurricane, while those in Pemba were untouched. The trees in Pemba, therefore, are from 60 to 90 years old, but those in Zanzibar date mostly from 1872 downwards. The average output of the African cloves has been about 14,000,000 lbs. a year, while the crop reached a record in 1911-12 when it amounted to 28,000,000 lbs. of which Pemba alone contributed 20,000,000 lbs. This record has, however, been exceeded by the bumper crop of 1918-19 which is reported to have yielded nearly 29,000,000 lbs. of cloves.

Ninety eight trees are planted to the acre. The average yield per annum from a plantation of about 3,000 trees of about 60 years old, under European management, is reported to be 8 lbs. per tree.

The price of cloves varies according to the size of the crop. In recent years it has fluctuated from Rs. 8-8 to Rs. 45-9 per frasila of 35 lbs. Prices for Zanzibar cloves ranged from Rs. 9 to Rs. 45·9 and those for Pemba cloves from Rs. 8-8 to Rs. 35. An export duty of 25 per cent. is levied by Government on the cloves.

The true cloves of commerce are the dried flower buds of Eugenia Cariophyllata, N. O. Caryophyllaciæ clove-stems are the stalks to which cloves are attached from the branch. These stalks or stems were known to contain a fairly large amount of brown dyestuff which was used by the African natives for dyeing their garments with. It was later found that the stems also contained

According to Parry, none of the methods suggested for the determination of eugenol, give absolutely correct results; but they are useful so far as comparative results may be obtained. According to the same author, a sample of Clove oil which gave 75 per cent. eugenol by Thom's method should give at least 82 per cent. by Umney's method, usually from 85 to 90 per cent.

The free eugenol in the oil was estimated by the volumetric method of Varley and Bolsing which is based upon the conversion of the phenol into its acetate by means of an acid anhydride in pyridine solution; the excess of anhydride which is absorbed by the pyridine is titrated with standard alkali, and the amount combined with the phenol calculated. The authors claim that their process can give results correct within ½ per cent. The amount of eugenol existing in an uncombined state in the oil was found to be 69·86 per cent.

I give below data for the calculation of the cost of production of the oil. The figures refer to actual costs incurred during the experiments described above. The expenditure on items 2 and 3 can be relatively reduced when the work is carried on a larger scale.

Data for the Cost of Production of the Oil.

	Rs.	A	P
1. 1 maund clove stems at Rs. 3 per 40 lbs. lot	6	4	0
2. 4½ maunds coal for boiler at Rs. 15 per ton	2	11	0
3. *Labour*—			
1 Mechanic at Rs 60 a month	2	0	0
1 Fireman at Rs 19 a month	0	10	0
1 Coolie at Rs. 8 a month	0	4	6
4. *Depreciation on Plant*—			
(*a*) On the copper still and parts at 22·5 per cent. per year on cost	0	12	0
(*b*) On boiler	0	4	0
5. Repairs	0	1	0
6. Insurance charges, interest on Capital, office charges, water, etc., not taken into consideration in the present case		*nil*	
Nett yield of oil=3·7 lbs.	12	14	6
or say,	13	0	0
Whence the cost of production of 1 lb. of oil	3	8	3 only.

The properties of the oil made from clove stems at this Laboratory are tabulated below in Table 1 for sake of comparison, along-

side similar characteristics in Table II obtained by analysis of different samples of clove oil, as quoted by Parry:

TABLE I.

Name and origin of oil.	Specific gravity at 35° C.	Optical rotation	Index of refraction at 35° C.	TOTAL EUGENOL. By absorption with 5 per cent. KOH Umney's method.	TOTAL EUGENOL. As benzoyl-eugenol by Thom's method.	Free eugenol.	Solubility in alcohol.
Oil of clove stems distilled at Cawnpore	1·0541	..	1·53450	93·09%	83·53%	60·86	Soluble in 0·5 vols. of 80 per cent. alcohol, with more than vols. opalescance not removed even by 9 vols. alcohol.

TABLE II.

(*Parry*: "The Chemistry of Essential Oils.")

Name and origin of oil.	Specific gravity at 15° C.	Optical rotation.	Index of refraction.	TOTAL EUGENOL determined by absorption with 5 per cent. KOH solution Umney's method.	Solubility in alcohol.
Oil of cloves B. P. . .	1·0401	—0°41′	1·53146	88·2%	Soluble in 1 to 1·5 vols. and more 70 per cent. alcohol.
Oil of cloves of Zanzibar .	1·0444	—0°48′	1·53020	84·5%	Soluble in 1 to 1·5 vols. 70 per cent. alcohol; with more than 5 vols. cloudiness which is only very slight with 10 vols. soluble in 0·5 vols. and more of 80 per cent. alcohol.
Oil of clove stems . .	1·0202	—1°36′	1·52881	80%	Soluble in 0·5 vols. 80 per cent. alcohol, with more than 2 vols. cloudiness which has again disappeared about 9 vols.

The oil of clove stems described in Table II is inferior to that described in Table I. The latter is even superior to the true oil of cloves of Table II. It is richer in its eugenol and consequently higher in specific gravity than an average sample of true clove oil; this, in my opinion, is due to the age of the stems.

From the above considerations it is not easy to see why the oil of clove stems should be valued lower than the oil from true cloves. The difference between the oil obtained from the two sources should be only in quantity and not in quality. The true cloves are said to yield oil up to 20 per cent. and the stems up to 6 per cent. In the present case the stems have yielded only 4½ per cent. If the price of clove oil were fixed by the eugenol contained in it, the oil obtained from stems as described in this paper should certainly fetch a higher value than an average sample of clove oil in the market.

It will not be out of place here to quote the opinion expressed by a leading and influential firm in India on the clove oil distilled from clove stems as described in the present report. "We have examined the specimen of clove oil from Mr. Gadre, and our Laboratory reports that it answers all B. P. tests, contains 95 per cent. eugenol, and in colour and aroma is equal to good quality English distilled oil of cloves."

The oil is used to a certain extent in pharmacy, but finds a larger use in the preparation of liqueurs and in perfumery. On account of its germicidal properties it found, during the war, a wide application in certain diseases of camels. For the manufacture of artificial vanillin during the war clove oil was greatly in demand. The price of oil has within recent years exhibited very wide fluctuations and had reached 24*s*. per lb. but has fallen to 18*s*. per lb. at present while it used to be about 6*s*. a lb. before war.

Although the clove stems have to be imported into India, their distillation in India appears to be a commercially paying proposition. A parallel can be found in the distillation of patchouli oil, which is done to a considerable extent in India with imported raw material. My experiments go to show that by careful and judicious working it is possible to obtain quite a good quality of clove oil from the stems, and I would venture to suggest that these stems may be used as the main source of supply of the clove oil of trade, leaving alone the true cloves to meet the other needs for which they are greatly in demand. As regards the supply of clove stems, it

should be possible to obtain it, with proper organisation, for a comparatively cheap price and in sufficient quantities.

In conclusion, I wish to express my thanks to Mr. B. C. Mukerji, M.Sc., for supervising the distillations.

S. T. GADRE.

THE GILT WIRE AND TINSEL INDUSTRY AT BURHANPUR, CENTRAL PROVINCES.

BY

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Deputy Director of Industries, Central Provinces.

The exact date of the introduction of the drawplate system of wire making into India is difficult to determine; in Europe it is believed to have been first attempted early in the fourteenth century; in England probably not until the reign of Elizabeth. The existence of that ancient foundation known as the Livery Company of Gold Wire Drawers in the city of London points to the fact that the industry was started at a fairly early date, as presumably the company was not formed until the trade was well established. That the ancients were familiar with wire in another form, that is in thin shreds or filaments of hammered metal, we know from the information given in a treatise on "Wire, its manufacture and uses" by Mr. Bucknall Smith. This writer informs us that wire was manufactured in shred form as far back as seventeen hundred years before the birth of Christ, he also records that a specimen made by the Ninevites about nine hundred years later is exhibited in the Kensington Museum and that metal heads with imitation hair of wire were recovered from the ruins of Herculaneum.

We have it on record that Sir Thomas Roe, Ambassador from James I to the Emperor Jehangir, paid a visit to the then Governor of Burhanpur, Prince Parwez, son of Jehangir; he described the country as "miserable and barren, the towns and villages built with mud" and he further gives an account of the pomp, magnificence and luxury obtaining in the Moghal Governor's Court. Tavernier visited Burhanpur in 1641 and again in 1658, in the course of his journeys between Surat and Agra, this traveller describes it as "a large much ruined town, of which the houses are for the most part covered with thatch. It has a large castle,*

* Portions of this still stand; the Turkish bath of the *zenana*, which is in excellent preservation, is now in use as a Dak Bungalow.

still standing in the middle of the town, and it is here the Governor resides." He mentions also a great trade in *Kinkob*, or gold thread embroidery, which "are transported into Persia, Turkey, Muscovia, Poland, Arabia, Grand Cairo and other places." From this evidence and from further writings of these two travellers it would appear that, although the Governor lived in great comfort and affluence in their midst, the style of living and condition of the ordinary inhabitants of Burhanpur and the workers in this luxury trade in particular left much to be desired. Burhanpur in 1658 was plundered by the Marathas and it seems that at this time the industry fell off considerably with the departure of the luxurious Mohamadan rulers. In Burhanpur there is in existence still a *sanad* to one Chunilal "chowkasee," or gold tester, granted to him by Akbar, and as the descendants of Chunilal still ply their trade in this town in much the same way, we may safely deduce that the silver gilt wire industry, as now carried on at Burhanpur, owes its inception to Akbar's conquests in Berar and in the subsequent Moghul influence.

The preparation of a silver ingot is the first operation towards the production of gilt wire and is carried out by an artisan known as a *pasaband*. About 59 tolas of silver with 3 of copper are melted in a crucible with a little borax as flux, the molten metal being poured into a small mould about ten inches long of rectangular cross section; the ingot thus obtained is then alternately hammered and annealed until a rod some fifteen inches long and about $\frac{5}{8}$th inch diameter is produced. After the final annealing the surface of the silver rod is roughened with a file, gold leaf is then applied to its surface and after reheating is well rubbed with a smooth stick; the amount of gold leaf used determining the final colour of the wire. The rod is again subjected to a further hammering, the process of heating, rubbing and hammering being repeated several times until some four inches have been added to its length; the rod is then ready to be drawn into wire. The operation of drawing the gilded rod thus prepared is carried out by a *pasatania*. The process consists shortly of drawing the rod through a series of graduated holes in a steel drawplate by means of tongs attached to a stout chain, which in turn is taken round a stout wooden roller having three or four spokes or arms attached radially, the ends of the roller being supported by wooden sockets, the whole thus forming an elementary windlass.

The drawplate is supported by stout wooden posts and, needless to say, the whole apparatus is on ground level, a hole being dug to accommodate the man who operates the windlass. The prepared rod, or *pasa* as it is called, is forced through the holes in the drawplate by considerable muscular effort on the part of the windlass worker and is annealed several times during the operations and also lubricated with wax.

The above process is continued until a wire some six or seven hundred yards long has been produced, it is then cut into one hundred yard lengths and the process repeated by *tanias* or wire-drawers in a similar but lighter form of apparatus, the wire finally produced is exceedingly fine, a thousand yards weighing about a tola. The gilt wire may then be converted into (1) *badla* or tinsel (2) *kalabathu* or tinsel-covered silk thread.

The drawplate used by the *pasatania* consists of a piece of steel about ten inches long by two inches broad and about one-half inch thick; it is perforated with two or three rows of tapered or rather funnel-shaped holes graduated in size, each hole being smaller in succession. Several plates are used, the holes of which are graduated in sequence down to the final diameter of the finished wire. These drawplates are not manufactured locally but are procured from Poona or Rajputana; the plates used by the *tanias* for the final drawing of the wire are, however, prepared in Burhanpur by the *tanias* themselves, it is said from old sword blades and hilts. The holes are not drilled but punched and cut with a succession of small tools; the process is laborious and requires a considerable amount of skill.

It is a curious fact that, although wire about as thick as a human hair is produced from a gold plated rod some five-eighths of an inch in diameter coated only with a thin film of gold, the finished article appears invariably to be wholly covered with gold and no patches or breaks in the covering can be observed.

Badla is prepared by *Chapudias* by a very simple operation as follows: About twelve small reels, on which the gilt wire has been wound, are fixed vertically on a board; the twelve wires are then led through twelve holes in a vertical plate on to a small flat anvil, having a highly burnished surface, where they are flattened by the single stroke of a hammer, the face of which is finished in a like manner to the anvil. The shaft of the hammer is hinged at the end to two small pegs in the ground and the hammer head

is raised by the right hand of the operator and allowed to fall, the flattened wires being drawn by the left hand past a guide formed by a glass rod and finally wound upon a reel. The preparation of *kalabathu*, or silk thread covered with *badla*, is an operation requiring considerable skill and dexterity; silk thread composed of six twists and manufactured locally from silk imported from Poona or Murshidabad is first wound on a spindle, one end being taken through a glass ring attached to the ceiling and fastened to a second spindle. The worker, or *Bataiya* as he is called, gives the second spindle a twisting motion by rolling it between the palm of his hand and his leg; while the silk thread is spinning the *badla* is applied with the result that the silk thread is covered with a spiral of tinsel evenly coiled and with no edges overlapping.

The process described above is also used for the preparation of similar articles in silver, the method of the production being exactly the same, except of course that no gold leaf is employed. There are various uses to which *badla* and *kalabathu* can be put. Formerly, a world-wide trade was carried on from Burhanpur in *kinkob* or gold embroidery for the manufacture of which *kalabathu* is essential. This form of needlework was in great demand for royal robes, saddle cloths, elephant trappings, caps and even carpets. It derives its name from the stretchers or horizontal members of a rectangular frame in which the material is held while the design is being worked. There is unfortunately little or no demand for this work nowadays and it is confined to small articles such as caps, pagri fringes and the like; large pieces are now only undertaken to special order. There is still a small trade carried on locally in the manufacture of gold and silver ribbons; these are woven on very small looms the warp being *badla* and the woof silk thread: similarly patterns in *badla* and *kalabathu* are woven in the centres and edges of coloured silk ribbons of varying widths.

There is little doubt that, were it not for the apathy and conservative nature of the workers themselves, the Burhanpur industry, endowed as it is with hereditary talent, might be resuscitated and placed on a sound commercial footing if more modern methods were employed. The workers appear on enquiry to be quite content to pursue the same methods their forefathers practised nearly four hundred years ago; any suggestion of new ideas or the application of simple machinery is met with the reply that they are convinced the quality of the work would suffer. This antipathy of

the old-fashioned handworker to adopt machinery and more modern methods is not peculiar to the East and can be traced in the history of most European industries. It would seem that there is here an excellent opening for an enterprising individual, with a little capital and some organizing ability, to revive the Burhanpur trade to something like its former state.

It would be a comparatively simple matter to arrange a draw-bench fitted with an endless chain, the tongs which grip the end of the silver rod being fastened to a carriage hooked to the chain, the carriage thus travelling along the bench when the chain is set in motion, with an arrangement for "tripping" it automatically when reaching the end of the bench. Such an arrangement is commonly in use for the manufacture of brass and steel rods, tubes, etc., and could either be power-driven or manually operated by a heavy geared fly-wheel By this means, apart from ease and economy in working, a steady pull would be exerted instead of the bar being spasmodically jerked through by the struggles of the windlass worker, subjecting the material to a series of shocks necessitating in all probability more annealing than would be required in a more modern process. The preparation of tinsel or *badla* might easily be carried out by a simple mechanical arrangement, turned by hand if necessary, having a reeling attachment similar to a sewing machine, the light hammer used being operated by a cam. With regard to the manufacture of *kalabathu*, a machine such as is used for covering electrical instrument wire with fine silk could in all probability be adapted.

European competition, which came mostly from Lyons in France, is said to a large extent to have been detrimental to Burhanpur trade prior to the war; in view of the fact that competition from this quarter will, in all probability, not be felt during the next few years, it would not appear to be unwise to endeavour to re-establish the fortunes of this ancient and historic industry.

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TRADE NOTES ON BAUXITE.

BY

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[NOTE.—This is one of a series of papers written by Dr. Coggin Brown on Indian Minerals. They deal with the industrial uses of the minerals, the specifications and standards of quality demanded in the trades concerned, the general methods of the markets and the sources of competing supply.

In order to complete the notes and render them useful to the prospector and miner as well as to the merchant, a brief description of the mineral, its distinctive characteristics and its occurrences in India is also given. Fuller information on these points may be obtained from the Geological Survey of India, Calcutta.

Similar notes on Manganese, Magnesite, Monazite, Corundum, Garnet, Wolfram, Antimony, Bismuth and Arsenic have been published or are in the press. Notes on Chromite and on Molybdenite will also be published shortly. [See outside cover.] Information regarding firms dealing in these minerals may be obtained on application to the Indian Trade Commissioner, London, or the Director of the Geological Survey, Calcutta.—Ed.]

Composition and Appearances.

Bauxite is a clay like hydroxide of aluminium regarded by some writers as a definite mineral species, having the empirical formula $Al_2O_3.2H_2O$, corresponding with $Al_2O_3 = 73{\cdot}9$ and $H_2O = 26{\cdot}1$ per cent. Chemical analysis shows that it rarely has this composition. It is usually found to be intermediate between $Al_2O_3.H_2O$, a mineral known as diaspore, and $Al_2O_3.H_2O$ or gibbsite. It seems, in fact, to be a mixture of these two hydrates of aluminium in an amorphous condition. In India, bauxite occurs in association with deposits of laterite and there is considerable divergence of opinion as to the mode of origin of this material. But whatever its derivation may be true laterite is essentially a mixture of ferric hydroxides, aluminium hydroxides, and free silica in varying proportions. Detrital laterites are often contaminated with mixtures of clay and sand. Between laterite and bauxite there is no sharp dividing line and one shades insensibly into the other. The laterites have been divided on chemical grounds into the following three groups :—

(1) Laterites (including bauxite laterites) with 90 per cent. or more of the hydrates of aluminium and iron.

(2) Argillaceous laterites, in which these hydrates total from 50 to 90 per cent.

(3) Laterite clays, with less than 50 per cent. of the two hydrates.

These groups are again subdivided on the basis of mineral composition but this need not be considered here.

The hardness, colour, density and composition of the commercial bauxites varies from place to place. In general it may be said that the material never shows any indication of crystalline structure, being compact or earthy, or often with a concretionary (oolitic or pisolitic) structure. Rarely it exhibits a granitic appearance. It may be soft and clay-like or hard and massive. The softer kinds may become harder on exposure. Its colour ranges through shades of red, brown, grey and yellow to white. The creamy and buff to yellowish tints are common in India.

Field Tests.

It is not easy to distinguish bauxite from clay. The former is said to granulate when rubbed between the fingers, instead of becoming plastic, and a soft bauxite to vary in its degree of granulation or plasticity, according to the proportion of bauxite to clay, or, in other words, of hydrated alumina to hydrated silicate of alumina in it. An American writer states that some measure of the relative quality of dried bauxite can be had by grinding a sample in an agate mortar for half a minute. A bauxite of good grade will be found hard to grind, and will stick to the mortar with such tenacity, that it will have to be scoured out; a poor bauxite, or bauxite clay will grind much more easily and will stick very little, if at all; and clay or kaolin grinds with ease and does not stick to the mortar. Similar results are obtained if the sample is rubbed on glass; the glass will not be scratched even by high grade bauxite.

Although such rough tests, coupled with the general pisolitic or round shot-like appearance, set in a fine-grained matrix, may serve to distinguish some kinds of bauxite in the field, it cannot be too strongly insisted that the only way to determine the quality of the mineral is by careful chemical analysis. This must show not only the total quantity of alumina present, but also the silica, iron and titanium oxides and water.

Distribution in India.

The richest bauxite areas yet discovered in India are on the

Central Provinces.

Baihir plateau in the Balaghat district and in the neighbourhood of Katni in the Jubbul-

pore district, both in the Central Provinces. But valuable ores have also been found in the States of Sarguja and Jashpur, and in the districts of Mandla and Seoni, also in the Central Provinces. Eight analyses of specimens and samples of the Balaghat bauxites have given results ranging between the following limits:—

	Per cent.
Alumina	51·62—58·83
Ferric Oxide	2·70—10·58
Titanic Acid	6·22—13·76
Silica	0·05— 2·65
Combined Water	22·76—30·72
Moisture	0·40— 1·14

corresponding to 71·2 to 80·8 per cent. of alumina after calcination.

From these figures it will be seen that the Balaghat bauxites are of very high grade. Analyses have shown that those of Jubbulpore are of a similar degree of purity. There seems also to be little doubt that large quantities are available. (Fermor.)

Bihar and Orissa.

Bauxite of excellent quality exists in Western Chota Nagpur, though the occurrences are local and not of large extent. The most favourable places for its formation appear to be the cliff margins of the smaller isolated plateaux, or the vicinity of gentle stream beds on the larger plateaux. The rich grey deposit invariably passes down into a poor ferruginous laterite. (Fox.)

Mysore.

Bauxite has been found in considerable quantities associated with the iron ores of the Bababudan Hills. A series of analyses of samples from the Kemmangundi area show the following range in composition:—

	Per cent.
Alumina	34·20—62·50
Ferric Oxide	5·10—40·70
Silica	0·26—13·60
Water	20·00—31·90

It appears probable that a considerable area of lateritic bauxite may exist on the tops of the hills at the head of the Kemmangundi valley.

Other Localities.

Valuable deposits of bauxite have been located in various parts of India in addition to those already mentioned. These include the Bhopal, Rewah and Tonk States of Central India, the Satara district of Bombay, certain parts of the Madras Presidency and elsewhere. Owing to the attention which has recently been paid to Indian bauxite and to

schemes for the manufacture of alumina and aluminium in India, the Geological Survey of India has decided to undertake a systematic examination of all the known bauxite deposits in the country, and to publish a memoir on the subject. This investigation is in progress at present.

Uses.

1. The chief use of bauxite is in the manufacture of aluminium, but it has other important applications as described below.

The world's production of aluminium has increased very rapidly in recent years. Before the war it was approximately 80,000 tons annually and by 1918 it had risen to the neighbourhood of 220,000 tons. In tonnage produced aluminium now ranks fourth amongst the non-ferrous metals, being exceeded only by copper, zinc and lead. The metal has an immense variety of uses which cannot be described in detail here. It is employed in the form of cables for the transmission of electric power, and finds very numerous applications in aeronautical and automobile engineering, in the manufacture of hollow ware for culinary and domestic purposes, in chemical and industrial processes where a rustless material is advantageous and for all kinds of ornamental work. Aluminium sticks and granules are used in ferrous metallurgy for deoxidising iron and steel. The powdered metal furnishes the intense heat required in the "Thermic" processes for welding iron, or for reducing the oxides of the rare metals. It is also used for paints, lights and flares and explosives. Aluminium forms a number of alloys with other metals, many of which are extensively utilised in the arts. Its value in times of war may be gauged from the fact that 90 per cent. of the total production in 1918 is said to have been absorbed for war purposes.

2. The purer varieties of bauxite are used in the preparation of salts of aluminium, notably of alum and aluminous sulphates. These are employed in water purification, dyeing, tanning, etc. A later note in this series will deal with the alum industry.

3. In the manufacture of artificial abrasives. These are made in the electric furnace,—notably at Niagara Falls, by fusing calcined bauxite. The product obtained is really a form of crystalline corundum which is marketed under various trade names, such as "alundum," "aloxite," etc. The quality of the product is said to be under complete control, a factor of considerable importance

in any abrasive industry. In 1918 approximately 112,908 long tons of bauxite were used for this purpose in the United States.

4. In the manufacture of bauxite bricks for furnace linings. The purer the bauxite used the more refractory is the resulting product. These bricks are said to be replacing the more costly magnesite and other refractory materials. They are made by mixing calcined bauxite or high-alumina clay with a bonding material such as fire clay, sodium silicate and lime. Another class of high alumina refractories is made by the electric fusing of bauxite. There is an increasing demand for them in the United States of America for the construction of various furnaces and cement kilns, and on account of the recent strides in the chemical industries of that country.

5. As a filtrating medium for the decolorisation and refining of mineral oils and various organic substances.

The only statistical data obtainable as to the amounts of bauxite used in the different industries are those of the United States. For 1918 they were as follows :—

	Per cent. of total bauxite output.
Aluminium Manufacture	69
Chemical Manufacture	10
Abrasives Manufacture	19
High-alumina refractories	2

Grades and Specifications.

Bauxite is graded according to its chemical composition and is sold to consuming industries on the basis of its analysis.

French Specifications.

The French bauxites are roughly classified into Red, White and White Siliceous groups. Analyses of these will be found on a later page. The red bauxite owes its colour to ferruginous impurities and is used in the manufacture of metallic aluminium. The white bauxites are employed in the preparation of aluminium salts and refractory materials. According to Pitaval and Ganet who wrote in 1913, bauxites for aluminium manufacture, are often obtained by mixing pure and impure materials; their composition, carefully fixed by analysis in each particular case, may vary between certain limits, which are usually as follows :—The average percentage of alumina from 57 to 60 per cent., it may reach 75 or even 80 per cent. The number of units of alumina above 60 gives rise to a bonus paid by the buyer. The percentage of silica must

not be over 3 per cent.; when it is below 2 per cent. the buyer pays a bonus in proportion to the decrease. The percentage of iron oxide may be between 10 and 15 per cent. or even up to 25 per cent.; above 15 per cent. the seller generally accepts a reduction in the price for each supplementary unit of Fe_2O_3. Finally, bauxites contain 10 to 20 per cent. of water, 1 to 2 per cent. of titanic acid, with a little lime, magnesia, and organic matter.

General conditions of the sale of French bauxite for aluminium manufacture.

Al_2O_3	equal to or greater than 57 per cent.	Above 60 per cent., a bonus of 0·20 to 0·40 per unit.
SiO_2	„ „ „ less „ 3 „ „	Below 2 per cent., a bonus of 0 20 per $\frac{1}{10}$ unit, maximum 3 per cent.
Fe_2O_3*	„ „ „ „ „ 14 „ „	Below 14 per cent., a penalty of 0·20 per unit, maximum 17 per cent.

The following tabular specifications are also given by Pitaval and Ganet. The prices of course refer to the markets in 1913:—

1. *White Bauxites (for chemical products).*

Guarantees.		Price.		Remarks.
Al_2O_3.	Fe_2O_3.	At the loading port.	On wagons at departure station.	
		Quality A.		
60 per cent. minimum	3 per cent. maximum	0·fr. 50 per unit of Al_2O_3 per tonne of 1,000 kilogs.	Deduction of 5 fr. per tonne from price at loading port.	Bonus in favour of buyer of 0 fr. 20 for each $\frac{1}{10}$ unit of Fe_2O_3 above 3 per cent. In case Fe_2O_3 exceeds 3·5 per cent. the buyer has the right of refusal.
	Note.—For a quality containing a maximum of 2 per cent. Fe_2O_3, the price is 2 fr. per tonne greater.			
		Quality B.		
57 per cent. minimum.	4 per cent. maximum.	27 fr. per tonne of 1,000 kilogs.	22 fr. per tonne of 1,000 kilogs.	

* This condition for iron oxides is not general; some works treat bauxites with 25 per cent. Fe_2O_3.

2. *White Bauxites (for refractory products).*

Composition		Price per tonne of 1,000 kilogs.		Remarks
Al_2O_3	Fe_2O_3	At loading port	On wagons at departure station.	
50—60 per cent.	3-4 per cent.	26 fr	21 fr	
50—60 per cent	2 per cent maximum guaranteed	28 fr.	23 fr	
50—60 per cent.	1 per cent maximum guaranteed	29 fr 50	24 fr 50	

From "Pitaval and Ganet" 1913

3 *Red Bauxites (low in silica)*

Guarantees.		Price per tonne of 1,000 kilogs		Bonus per tonne		Remarks
Al_2O_3	SiO_2	At loading port	On wagons at departure station	In favour of buyer	In favour of seller	
60 per cent minimum	3 per cent maximum	21 fr 50	16 fr	0 fr 25 for one unit of Al_2O_3 and 0 fr 50 for two units below 60 per cent	0 fr 15 for each 1 unit of 10 silica less than 2 per cent	Below 58 per cent Al_2O_3 the right of refusal by buyer

American Specifications.

American practice limits bauxites of commercial grade to at least 52 per cent of alumina It is stated that low contents of silica and titanium are essential to the makers of metallic aluminium, but the iron content may be fairly high Bauxites low in iron and titanium are preferred by the chemical manufacturers who produce alum and aluminium sulphate. Makers of artificial abrasives appear to be able to use lower grades containing larger amount of silica and iron oxides than are permissible in bauxite for other purposes, though abrasives are also made from bauxites low in silica and iron. The bauxite required for refractory purposes must be low in iron.

Current American specifications run on the following lines :—

For bauxite containing about 52 per cent. alumina, less than 2 of iron oxide and up to 20 per cent. silica, and artificially dried to contain not more than 4 per cent. free moisture, \$10 per gross ton at mine; 54 per cent. Al_2O_3 and about 15 per cent. SiO_2, \$11; averaging 57 per cent. Al_2O_3, 8 to 12 per cent. SiO_2, less than 3 per cent. Fe_2O_3, \$13 on basis of 8 per cent. free moisture. Ores of very low silica content suitable for manufacture of aluminium oxide and hydrate of alumina command a fancy price.

English Specification —(Metallurgical).

One of the large English aluminium-producing concerns states that the grade of bauxite most suitable for aluminium manufacture should contain :—

	Per cent.
Alumina	60 minimum.
Titanic Oxide	2 maximum.
Silica	2 „

Another company, also engaged in aluminium manufacture, writes that bauxite used for the production of aluminium should contain a minimum quantity of silica. It is generally stipulated that it shall not exceed 3 per cent. The alumina content should be from 55 to 60 per cent.

Chemical.

A large firm of English alum makers states that for the production of aluminium sulphates a quality of bauxite containing a minimum of iron and a maximum percentage of alumina is desired. The following may be taken as a representative analysis of a satisfactory quality :—

	Percent.
Alumina	60
Ferric oxide	3
Insoluble acid	12 or less.
Combined water	25

Another firm of manufacturing chemists regards the most suitable grade of bauxite as one of the following typical composition :—

	Per cent.
Alumina	60—65
Ferric oxide	5 maximum
Silica	10 „

It is however willing to consider lower grades, containing, say, 50—55 per cent. of alumina.

A third chemical firm writes that as there is at present a plentiful supply of bauxite to be found in Europe, any material from overseas would only be of interest if it was of a high class quality, that is containing 60—65 per cent. of Al_2O_3 or more, and less than 1 per cent. of SiO_2. The price would of course have to compare favourably with the present price of European bauxite.

Organisation of the Markets.

English Methods.

The large aluminium-producing companies of the United Kingdom control their own bauxite concessions. As far as can be gathered when such concerns purchase ores from external sources, no general form of contract is used. A price is agreed, for a given analysis and a unit price fixed per cent of alumina and per cent. of silica above or below both figures. Test samples are taken by both seller and buyer and in the event of dispute the analysis figures given by a chemist of standing are accepted by both parties Payment is usually made on presentation of the documents in London.

In the cases of bauxite required for other purposes, as for example in the manufacture of aluminium salts, the exact forms of contract and the period they cover are arranged between seller and buyer. Such contracts generally guarantee a percentage of Al_2O_3 and SiO_2 with possible allowances of so much per cent above or below the figures agreed upon Delivery dates are given and shipping weights taken as a basis The usual "Force Majeure Clause," as recognised by merchants in the United Kingdom, is added

It is customary for the mineral to be weighed and sampled during discharge of the steamer at the port of destination, and an English chemist of repute is appointed to settle the analysis.

Payment is made at the price per unit of Al_2O_3 in the mineral, "as delivered," per ton of 2,240 lbs.

French Methods.

The French bauxites are sold to French and other manufacturers of aluminium. These manufacturers, including the foreign ones, own nearly all the bauxite deposits of France. Direct sales are mainly to the United States and Canada.

Besides the large producers, there are many small suppliers for the mineral is easily won and anyone may open a quarry, after making a simple declaration to the authorities.

French business methods both for deliveries at home or abroad by rail demand full settlement of bills without discount within 30 days of the end of the month of delivery, and in the case of deliveries by sea, either in France or abroad, payment of 80 per cent. of the total cost, free of discount against the bills of lading, and the remainder immediately after receipt of the merchandise at the unloading port.

The weights taken are those in the trucks at the point of departure in the case of rail-borne bauxite, and those inscribed on the bills of lading for sea-borne mineral.

Sampling by both parties is done at the point of departure. Analysis on the mineral dried at 100°C. No deductions for moisture. In cases of dispute a fresh expert analysis at the cost of both parties.

American Markets.

The market for bauxite in the United States of America is east of the Mississippi River, and the largest consumers are located in or near the cities of East St. Louis and Aurora, Ill.; Detroit, Mich.; Cincinnati, Ohio; Knoxiville, Tenn; Philadelphia and Erie, Pa.; Niagara Falls and New York City, N. W.; and Boston, Mass. Of recent years a number of small plants for the manufacture of aluminium sulphate for local use in water purification have been installed by municipal water-works in the States.

Prices.

The only publication with which the writer is acquainted regularly quoting the market prices of bauxite is "The Engineering and Mining Journal of New York." The latest available prices (September 1920) are as follows:—

Alumina.	Iron Oxide.	Silica.	Water.	$
52	2 (max.)	20 (max.)	4 (max.) per cent.	10 per gross ton.
54	......	15	Ditto.	11 ,, ,, ,,
57	3 (max.)	8—12	8 (max.) per cent.	13 ,, ,, ,,

Ores of very low silica content command a fancy price.

The price received for bauxite in 1918, as reported by the producers, and as given in an official publication of the United States Geological Survey, ranged from $5 to $12 per long ton, the average

being \$5·69 per long ton at the shipping point. This price is very much below the open market rates which ruled during the period. It is explained by the fact that in the United States as elsewhere the larger consumers work their own mines, and the value assigned to the output is merely an arbitrary one, presumably based on operating costs.

Bauxite bricks guaranteed to contain 56 per cent. Al_2O_3 are selling at \$160 per 1,000 f. o. b. Pittsburgh, Pa.

Aluminium (metal).	Price in London. Per ton 98—99 per cent. pure.
June 1914	£81—83
January 1915	82—85
June 1915	100—105
January 1916	215 (nominal)
June 1916	155 „
January 1917	nominal.
June 1917	nominal.
January 1918	nominal.
June 1918	nominal.
January 1919	200
June 1919	150
January 1920	150
June 1920	165

On the American market aluminium is quoted in cents per pound.

Chief Sources of Supply.

United States of America.

The bauxite deposits of commercial importance in the United States of America are situated in Arkansas, Georgia, Alabama and Tennessee. The Arkansas deposits were discovered about 1887 in Pulaski and Saline countries. They have an average thickness of 10 to 15 feet, are closely associated with syenite intrusive rocks and are overlain by Tertiary materials. The ores are high grade and have supplied 80 per cent. of the bauxite mined in the United States.

The Georgia deposits are found near the margin of the Coastal Plain, about 30 miles east of Macon. They form beds up to 10 feet in thickness and are overlain by sands and clays. Georgia bauxite is more suitable for the manufacture of chemicals than for other purposes.

The Alabama bauxites form pockets and lenses in a residual clay derived from a dolomite. They are of greatest extent between Cave Springs, Ga. and Piedmont, Ala, and are used mainly in chemical manufacture.

The Tennessee deposits are of similar character to those of the Georgia-Alabama region and they have been developed in the neighbourhood of Chattanooga and in Carter County.

France.

The bauxite deposits of France are located chiefly in the south-east in the department of Languedoc-Provence (Herault, Bouches-du-Rhone and Var). They form a band extending almost parallel to the Mediterranean. The bauxite occurs in thick beds, alternating with clays and limestones and associated with folded Cretaceous rocks. The mineral is worked in open quarries and sometimes by underground mining, but the depth is seldom more than 50 metres from the surface. Analyses of the various types are given in the following table:—

Locality.	Variety.	Water.	Silica	Iron oxide.	Titanic acid.	Lime.	Alumina.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Var	Red	12·90	1·75	21·38	3·21	..	60·70
	Rose	14·70	19·13	5·11	3·52	0·52	56·96
	Lilac	15·09	8·11	3·07	2·85	..	70·80
	White	16·10	21·06	3·47	0·95	1·30	58·59
Bouches-du-Rhone.	White	19·80	12·30	3·45	3·70	..	60·20
	Red	19·80	2·20	14·00	2·50	..	61·30
Herault	White	15·10	1·60	0·67	3·80	..	78·53
	Red	12·50	5·25	24·21	2·28	..	55·51
	Rose	15·60	5·95	5·09	2·39	..	70·82
Ariege	Rose	14·79	12·02	4·71	3·02	Traces.	64·89

These figures are said to be generally correct for average material.* The iron oxide may sometimes make up 60 per cent. of the bauxite against only 0·5 per cent. at other times; the silica varies in similar degree.

The French deposits have furnished the world with large quantities of high grade bauxite. The production averaged 242,000

* Mineral Industry 1914, p. 37.

tonnes a year for the four years preceding the war and since then statistics have not been published.

Ireland.

There is no recent information available regarding the bauxite deposits of Co. Antrim in Ireland. They are believed to occur in beds amongst basalts of Tertiary age and to have been derived from the decomposition of these rocks. They are used for the preparation of alumina in the works at Larne. The output of bauxite is probably about 10,000 tons per annum.

British Guiana.

Bauxite deposits of considerable magnitude are known to occur in British Guiana where they have been traced almost from the Venezuelan boundary right through the colony to the Dutch border. The bauxites are aluminous laterites derived from the alteration of the gneissic rocks of the region Large leases on the Demerara River, about 60 miles from Georgetown, are now under development The first shipment was made in March 1917 and up to the end of 1918, 10,322 tons of high grade ore had been mined, and 8,097 tons exported to the United States of America. It is anticipated that the industry will develop quickly in the near future and that local treatment of the raw material by the aid of water power will take place.

Other Countries.

During the war the German aluminium factories are believed to have relied mainly on the Hungarian bauxite deposits for their supplies of raw material. These deposits occur in the Biharhegyzeg, in the Galbina valley and in the districts of Petrosz and Sykerisoia Other large deposits are also known to occur in Dalmatia and Crotia The deposits of the Bihar mountains are associated with Jurassic and Cretaceous limestones.

The requirements of the Italian makers are met to a large degree from the Terra di Lavoro district of Abruzzi in the Central Appenines where bauxite is interbedded with limestones of Cretaceous age. The mineral varies in composition as follows :—

Al_2O_3	54 60—58·85
Fe_2O_3	18·62—30·63
SiO_2	3·65— 7·91

Bauxite deposits are also known to occur in Spain, Germany, Austria, Servia, New South Wales, Western Australia, the Gold Coast, Dutch Guiana and several States of South America.

In Norway alumina and aluminium are extracted from labradorite felspar by the Goldschmidt process.

Statistics.

Tables are given showing:—

1. Estimated World's Production of Metallic Aluminium.
2. World's Output of Bauxite.
3. Imports of Metallic Aluminium into India.
4. Imports of Aluminious Sulphates into India.

The world's production of aluminium has increased very rapidly within recent years, rising from some 79,000 tons in 1913 to 222,000 tons in 1918. Before the war the distribution of production was as follows:—

	Per cent.
United States	33
Canada	8½
Germany, Switzerland, Austria-Hungary	17½
France	26½
United Kingdom	11
Norway	2½
Italy	1½

In 1918 the distribution of production was as follows*:—

	Metric tons.	Per cent.
Aluminium Co. of America / Northern Aluminium Co. of Canada	117,000 or	53
British Aluminium Co. (Great Britain and Norway)	19,000	10
The Aluminium Corporation Ltd.	3,000	
L'Aluminium Française (France and Norway)	32,000	14
Aluminium Industrie Aktien Gesellschaft, (Switzerland and Austria)	23,000	10
Hoyang Falden Norsk Aluminium (Norway)	...	...
L'Aluminio Italiano (Italy)	8,000	4
German Government Works	20,000	9
TOTAL	222,000	

The amount of bauxite produced in India represents, of course, only the small quantities which have been won for minor and experimental purposes, and is in no way a measure of the potentialities of the deposits.

* From "Mineral Industry" 1918.

The imports of metallic aluminium into India decreased, from 1,795 tons in 1912-13 to insignificant quantities in 1917-18. The trade however shows signs of a rapid recovery since then.

Aluminium is imported mainly in the form of circles and sheets which are worked up into hollow ware in India and also as unwrought ingots, blocks and bars. Smaller amounts of finished aluminium ware are also imported. In pre-war years, as far as figures are available the imports came from Germany, the United Kingdom, the United States of America, France and Belgium, in respective order of importance. The great increase in 1918-19 is due almost entirely to imports from Japan.

The trade in aluminous sulphates will be considered in detail in a later article.

*Estimated World's production of metallic aluminium (in metric tons.)**

Year	Austria.	Canada	France	Germany.	United Kingdom.	Italy	Norway	Switzerland	United States	TOTAL.
1913 .	5,000	5,916	15,000	..	10,000	874	2,500	10,000	29,500	78,790
1914 .	4,000	6,820	12,000	.	8,000	937	2,500	10,000	40,600	84,857
1915 .	2,500	8,490	7,500	..	6,000	904	3,500	12,500	45,000	86 394
1916 .	5,000	8,500	20,000	..	4,000	1,126	16,000	15,000	63,000	112,626
1917 .	5,000	11,800	20,000	..	6,000	1,740	18,000	15,000	90,700	170,740
1918 .	8,000	15,000	22,000	20,000	14,000	8,000	18,000	15,000	102,000	222,000

World's production of bauxite, 1913-1917 (in long tons).†

Country.	1913	1914.	1915.	1916.	1917.	1918.
United States .	210,241	219,318	297,041	425,100	568,690	605,721
France . .	304,314	(a)	(a)	(a)	(a)	
United Kingdom	8,282	8,286	11,723	10,329	14,724	..
Italy . .	6,841	3,844	5,807	8,739	7,666	
India . .	1.184	514	876	750	1,363	1,192
TOTAL .	530,862	..	..	..	..	..

* From "Mineral Industry" 1918.
† From "Mineral Industry" 1918 with additions.
(a)—Statistics not available.

Imports of metallic aluminium into India.

Year.	Tons.	Value.
1912-13	1,795	£170,097
1913-14	1,317	142,528
1914-15	777	87,046
1915-16	771	96,333
1916-17	41	12,290
1917-18	36	15,028
1918-19	582	149,213

Imports of aluminous sulphates into India (including alum.)

Year.	Tons.	Value.
1912-13	5,054	£31,146
1913-14	4,505	28,155
1914-15	6,340	36,433
1915-16	6,595	55,266
1916-17	7,764	88,968
1917-18	5,160	87,721
1918-19	3,282	49,107

Outlook for Bauxite in India.

The large scale development of the bauxite deposits of India was considered by Sir T. H. Holland in 1907. He showed that it might be brought about in three possible ways :—

(1) Simple export of the raw or calcined material to Europe or America for use in alumina factories.

(2) Manufacture of pure alumina locally by extraction with alkali for export to aluminium works or for the local manufacture of aluminic salts.

(3) Manufacture of the metal in India.

The first proposal was dismissed as impracticable; the third would involve heavy capital outlay under untried conditions and elaborate investigation before power works could be erected. The second proposal involves smaller risks especially as it has been established that there are no technical difficulties in the way of making alumina from Indian bauxites.

Since that time several concessions have been taken out and the subject has received much consideration from various industrialists. Further, the growth of the aluminium industry in other countries has been rapid, while the investigations of the Hydro-Electric Survey of India and of private firms, have resulted in a more extensive knowledge of suitable sites for power stations.

The annual consumption of aluminium in India is comparatively small, though it will doubtless increase in common with other countries as industrial development proceeds. Any works erected to smelt the metal would at present be compelled to dispose of a portion of the production by export. For the benefit of those who are studying the question at present, it may be stated that the building up of successful aluminium enterprises in other countries has depended more on sufficiently cheap electrical energy and large scale production than on other factors in the problem.

J. COGGIN BROWN.

TRADE DISPUTES IN BENGAL.

BY

DIRECTOR OF INDUSTRIES, BENGAL.

An epidemic of strikes unprecedented in the history of the province broke out in Bengal in the year 1920. With extremely few exceptions, the strikes arose from demands for higher wages; and the general origin of the demands was the rise in the cost of living which resulted from the Great War. The popular hope that the Armistice would be followed by a substantial fall in prices was grievously disappointed; apart from economic reasons there were others that unsettled men's views of established things, and the general atmosphere was one that encouraged the not unnatural demand of industrial labour that some readjustment should be effected. The workpeople of Bengal are almost exclusively immigrants from other provinces who retain their foreign domicile and reside in bachelor messes in the immediate neighbourhood of their work. They work in two main groups, *viz.*, the major group that lines the banks of the river Hooghly in the vicinity of Calcutta, and the minor group that is stationed in and near the coalfields of Asansol. The chief labour elements lying outside these groups are the quasi-agricultural labour of the tea gardens and the labour employed on the Railways of the province and on the steamers that ply mostly on the waters of Eastern Bengal. Partly through their non-domicile in the province and partly through lack of education, the workmen of Bengal cannot be said to constitute a class in the sense of a social group aware of any corporate personality; and they are unpractised in the organizations that make for the common articulation of common desires. The strike as a means of obtaining concessions was not unknown before 1920, but it had appeared only in isolated cases, and the demands had more commonly been non-economic in character. What appears to have occurred in 1920 is that isolated strikes for higher wages in the Hooghly riverine, resulting in the concession of increases, were suddenly taken as a pattern of what might well be repeated, and there followed a process of accumulative imitation which gained in strength owing to the

continued successes achieved. This process was lubricated by public discussion in newspapers and by the active interest which was taken in some strikes by publicists not belonging to the working classes, who began to express on behalf of the men arguments regarding labour which had hitherto been heard more often in Western countries than in India. Up to date the process of adjustment has been on the whole amicable; the bulk of strikes have been comparatively short-lived, and their conduct has been commendably peaceable. In the course of them several tentative movements in the direction of forming economic labour associations have made their appearance; these are, however, mostly confined to smaller groups of employment such as press employees, taxi-cab and motor car drivers, tramway employees, Port Trust employees; and do not extend, for instance, to the great jute industry. A notable feature of a one day's strike called by the local branch of the Railway Workmen's Association at Kharagpur in October was the denouncing of the strike by the Central Association as unauthorised. Members of the legal profession have figured on behalf of the workmen in the settlement of several strikes, but not in the settlement of jute mill strikes.

An early place in the history of these demands for higher wages is taken by the jute industry. The employees of the jute mills had, by the 1st of January 1920, received three rises in wages amounting to a total rise of about 40 per cent on the pre-war rates. Some impression must have been created in Bengal by the big strike that occurred in Messrs. Tata and Co.'s work in Bihar and Orissa in February—March 1920; but the heavy series of strikes for higher wages does not set in until the latter half of the year, and within that half it falls mostly into the months of October, November and December. The few strikes that occurred in Jute Mills in July and August were non-economic in origin. A new demand for a further rise in wages appeared in Jute Mills in September, and a three-day strike in one mill was followed by the concession of a further rise throughout the industry of about 10 per cent calculated in pre-war rates. The most important occurrence in the third quarter of the year was the strikes in the Government of India and Government of Bengal Presses, Calcutta. These two strikes, which continued into October and ended in failure for the strikers, resolved themselves ultimately into a strike of compositors for the abolition of the piece work system of pay. The employer was Government, public sympathy was invited

in frequent meetings by speakers who used political as well as economic arguments, and the lengthy resistance put up by the men created considerable impression. This impression was deepened in October by an unsuccessful strike in the Gas Works which deprived Calcutta of light for more than a week, and by a successful three-day strike in the Calcutta and Howrah tramways which further inconvenienced the public. In October and November, unrest, which was first revealed in July and August respectively by two short-lived strikes in the Port Trust Railway and among the hydraulic cranemen who work at the jetties, spread extensively to several groups of labour engaged in the handling of ships and cargo, and in godowns and depôts within the port of Calcutta.* In November the number of disputes in progress was thirty-eight, and important industries newly affected were foundry and engineering works (including one concern in the Asansol subdivision) and cotton mills. At the end of November, definite unrest appeared in the coalfields of Asansol and resulted in several strikes in the beginning of December. By the end of the year there was practically no group of employment in the Hooghly riverine and the Asansol area in which strikes had not occurred. A noticeable occurrence in the beginning of December was the failure of a strike in the jute industry for a further rise in wages.

A peculiarity of the disputes regarding wages that have occurred since 1917, in jute mills, and have resulted in four increases, is that the demands have arisen in each case in one or more of five mills that form a group immediately centering upon Calcutta. The concessions granted to these mills have in each case been reflected by similar concessions immediately granted throughout the industry, the rest of the mills (22 in number) not going out on strike. A common feature of these disputes has also been that they originated in demands made by the skilled workmen in the factory section.

The bulk of strikes have been accompained by picketing; and solidarity has been achieved in individual concerns by methods of intimidation which have proved, as always, difficult to combat. It has been sufficient generally for those most interested in the strike to place any who might be recalcitrant under verbal threats of violence to their person or property. Actual violence has not been commonly resorted to.

*Among these was a strike of stevedores coolies which seriously threatened to hold up the commerce of the city.

Apart from the Hooghly riverine and the Asansol area, strikes have occurred only in Barisal. During the dispute in the Government presses in Calcutta the employees of five presses in that town went on strike, and during the disputes in the port of Calcutta a strike occurred there among the employees of the Steamer Company's workshops.

A record of strikes occurring within the province was opened in the office of the Director of Industries, Bengal, on the 1st of July 1920. District Officers were directed to submit to that office a report on all strikes occurring within their jurisdiction, grouping the facts under specified heads. The record compiled in the office of the Director of Industries is based upon these reports and upon such information as employers, when called upon, have been good enough to supply. The record will be brought under review in this journal once every quarter, in tables designed to afford a continuous record of statistics, showing the number and duration of strikes and the number of employees involved in them, in forms similar to those used by the Ministry of Labour in England.

The duration of strikes is expressed in "working days," *i.e.*, in a figure obtained by multiplying the number of employees out of work owing to a strike by the number of working days for which the strike lasts.

The present report should deal with the third and fourth quarters of 1920. It has been called for, however, too early for a sufficiently accurate statement regarding the latter part of the fourth quarter; and in that quarter completed figures are given for the months of October and November only. A final table for the quarter will be given in the next report.

Third Quarter (July—September) 1920.

Number, magnitude and duration.—The number of disputes involving a stoppage of work was 19. They were all strikes and there was no lock-out. They all began during the quarter and ended during the quarter. They involved 31,717 work people and lasted 187,941 working days. The heaviest item is under Printing Presses, owing to strikes in the Government of India Press and the Government of Bengal Press, Calcutta, which began in July.

Causes.—Of the 19 disputes, 13 arose from demands for higher wages. The remaining 6 were non-economic in origin.

Results.—Of the 19 disputes, 4 resulted in the concession of the terms demanded by the work people; 9 in the concession of modified terms, and 6 in complete failure for the work people. Among these last were the two strikes in Government Presses.

The following table classifies the disputes by groups of trades and shows the number of work people involved at the establishments concerned, and the approximate time lost by these people during the quarter.

Trade Groups.	No. of disputes in progress.	No. of employees involved	Aggregate duration in working days.
Jute Mills	6	18,196	43,600
Cotton Mills	1	1,000	2,000
Port Railway	1	120	120
Docks, Jetties (Mechanical)	1	175	350
Printing Presses	8	1,526	91,521
Godowns and Depôts	1	700	350
Tailors	1(*a*)	10,000	50,000
TOTAL	19	31,717	1,87,941

The table in the next page shows the incidence of the same ures in each month of the quarter:—

(*a*) A strike common to about 1,500 concerns.

Trade Groups.	JULY. No. of disputes in progress.	JULY. No. of employees involved.	JULY. Aggregate duration in working days.	AUGUST. No. of disputes in progress.	AUGUST. No. of employees involved.	AUGUST. Aggregate duration in working days.	SEPTEMBER. No. of disputes in progress.	SEPTEMBER. No. of employees involved.	SEPTEMBER. Aggregate duration in working days.
Jute Mills	2	5,196	10,600	1	4,000	6,000	3	9,000	27,000
Cotton Mills	1	1,000	2,000	..	..	..	..	..	..
Port Railways	1	120	120	..	..	..	..	..	..
Docks, Jetties (Mechanical)	..	..	..	1	175	350	..	..	..
Printing Presses	7	1,517	18,476	3	1,492	38,045	2	1,483	35,000
Godowns and Depôts	..	..	..	..	..	..	1	700	350
Small Tailoring firms, Calcutta	..	..	..	..	..	..	1(a)	10,000	50,000
TOTAL	11	7,833	31,196	5	5,667	44,395	7	21,183	112,350

[(a) A strike common to about 1,500 concerns.

Fourth Quarter (October—December) 1920.

The information available for the month of December, in which several strikes occurred in the industrial area in the west of Bengal, is at present far from complete. Final figures for the months of October and November are accordingly given, followed by a provisional statement for the month of December.

October and November.

Number, magnitude and duration.—The number of disputes involving stoppage of work was 48. They were all strikes and there was no lock-out. They all began during the period. They involved 92,665 workpeople and lasted 468,942 working days. Thirty-five of them, involving 50,865 workpeople, were settled during the period, leaving a balance of thirteen disputes, involving 41,800 workpeople, which continued into December. One-third of the workpeople involved were jute mill employees; almost one-third of the working days lost were the working days of jute mill employees, and a quarter were the working days of employees in Foundry and engineering works. A strike of considerable commercial importance was the strike of cargo handlers working under Stevedores in the port of Calcutta which began on the 1st of November, involved 1,100 men, lasted eleven days, and resulted in an inconvenient congestion of shipping.

Causes.—All the 48 disputes arose from demands for higher wages.

Results.—Of the 35 disputes that were settled during the period, 2 resulted in the concession of the terms demanded by the workpeople; 27 in the concession of modified terms, and 6 in complete failure for the workpeople. Among these latter was a strike in the Gas Co., Calcutta.

The following table classifies the disputes by groups of trades and shows the number of work people involved at the establishments

concerned, and the approximate time lost by these workpeople during October and November:—

Trade Groups.	No. of disputes in progress.	No of employees involved.	Aggregate duration in working days.
Jute Mills	6	38,500	1,89,500
Cotton Mills	2	2,000	4,000
Foundry and Engineering Works	9	15,770	1,14,140
Motor Works	4	900	12,125
Docking Works	4	5,548	42,735
Other Metal Works	3	800	2,050
Railways	1	10,000	10,000
Port Railway	1	200	600
Navigation	1	900	2,700
Cargo handling	3	1,450	13,150
Docks, Jetties (Mechanical)	3	590	4,600
Tramways	1	2,500	7,500
Gas Works	1	1,100	20,000
Jute Presses	3(*a*)	2,150	9,300
Godown and Depôts	3(*b*)	4,750	21,000
Municipal Employees	1	2,500	12,500
Shops	1	7	42
Coachmen	1	3,000	3,000
TOTAL	48(*c*)	92,665	4,68,942

(*a*) One of those was a strike common to 19 concerns, and one a strike common to 18 concerns

(*b*) One of these was a strike common to 4 concerns.

(*c*) None carried over from previous quarter.

The table below shows the incidence of the same figures in each of these two months :—

Trade Groups.	OCTOBER.			NOVEMBER.		
	No. of dispute in-progress.	No. of employees involved.	Aggregate duration in working days.	No. of disputes in progress.	No. of employees involved.	Aggregate duration in working days.
Jute Mills	1	4,000	5,000	5	34,500	1,84,500
Cotton Mills	..	..	..	2	2,000	4,000
Foundry & Engineering Works	..	..	..	9	15,770	1,14,140
Motor Works	3	750	4,925	3	750	7,200
Docking Works	1	1,250	6,250	4	5,548	36,485
Other Metal Works	..	..	..	3	800	2,050
Railways	1	10,000	10,000	..	..	..
Port Railway	1	200	600	..	..	..
Navigation	1	900	1,800	1	900	900
Cargo handling	..	..	..	3	1,450	13,150
Docks, Jetties (Mechanical)	1	240	1,200	2	350	3,400
Tramways	1	2,500	7.500	..	..	..
Gas Works	1	2,100	10,000	..	..	..
Jute Presses	1	50	100	2(*b*)	2,100	9,200
Godowns & Depôts	1(*a*)	4,000	20,000	2	750	1,000
Shops	1	7	42	..	..	..
Municipal Employees	..	..	..	1	2,500	12,500
Coachman	..	..	..	1	3,000	3,000
TOTAL	14(*c*)	24,997	77,417	38	70,418	3,91,525

(*a*) A strike common to 4 concerns.
(*b*) One of these was a strike common to 10 concerns, and one a strike common to 18 concerns.
(*c*) None carried over from the previous month.

December.

The following provisional table shows the figures available up to date. Out of the total of 52 disputes, involving more than 86,000 workpeople, 30 disputes, involving more than 71,800 workpeople, are known to have been settled during the month.

Trade Groups.	No. of disputes in progress.	No. of employees involved.	Aggregate duration in working days.
Jute Mills	11	63,000	3,77,500
Cotton Mills	4	3,660	+
Foundry and Engineering Works	10	11,020	1,23,340
Motor Works	1	1,500	27,000
Docking Works	2	1,300	9,000
Cargo handling	3	3,650	15,100
Docks, Jetties (Mechanical)	2	400	2,000
Godowns and Depôts	1	2,000	16,000
Coal Mines	9	+	+
Potteries	2	400+	+
Paper Mills	1	+	+
Oil Mills	2	+	+
Taxi drivers	1	150	300
Municipal Employees	2	+	+
Cigarette Factory	1	16	48
TOTAL	52	87,096+	5,70,288+

DIRECTOR OF INDUSTRIES, BENGAL.

INDUSTRIAL EDUCATION IN MADRAS PRESIDENCY.

BY

W. FYFE,

Inspector of Industrial Schools, Madras.

I. Preliminary Training.

It is now generally accepted that if the industrial possibilities of the country are to be developed as they ought to be, much more attention and much more money must be devoted to the spread of industrial education. But the people who advocate the provision of more facilities for higher industrial training are few of them engaged in industry themselves. They are mostly engaged in commerce or the more learned professions of law and teaching. They realise that something should be done and their thoughts and habits of life naturally lead them into scholastic views. A careful consideration of the case ought however to convince the impartial thinker that the only men who are competent to pronounce an opinion as to what industry requires for its development are the men who have developed the industrial resources of the country up to their present stage. In other words the man who should be consulted, the man who alone is competent to judge the success or otherwise of schemes of industrial education, is the man who has to use the product; the employer of skilled and unskilled labour.

Before we set out then to train labour, *i.e.*, to produce skilled men of all the grades necessary to develop the industries of the country, we must first try to ascertain what the employers required and then how best to satisfy these requirements. If we take Mechanical Engineering as representative of industry in general and consult the local heads of Engineering establishments we find that their requirements are many and various but that they can generally be expressed in the phrase "a better educated type all round." They want first and foremost a better educated, more intelligent type of artisan, secondly a better educated and better trained type of chargeman and overseer, and thirdly a locally trained type of foreman who can compare favourably with the imported European product. Few employers express any desire for a supply of trained engineers of

College rank. They are required undoubtedly, but in this Presidency for many years to come the demand for them is not likely to be at all acute.

To start then with the employers' first requirement, a better type of artisan, how is he to be produced? If we examine the shortcomings of present type of artisan in order, we discover firstly that he is almost invariably nearly if not quite illiterate, and secondly that he has served no proper apprenticeship, and it has been nobody's business to teach him anything. He started as a coolie boy in the shop and picked up what knowledge he has in a haphazard sort of way. As a general rule he is an expert operator of one machine on one operation, but as an all round fitter or turner he is not particularly efficient. His lack of general education makes it difficult if not altogether impossible to convey orders to him in writing or by drawings, and he has a very hazy idea of the value of time. He is inclined to regard his own time as the only factor in the cost of a job and cannot be brought to understand that his machine has a value too, and that if he stays away from work on feast days and Mondays, his machine standing idle represents a considerable loss to his employer.

What can be done to make this artisan more efficient as a producer? That is our first problem. The obvious thing would appear to be to start industrial classes for his benefit, but you cannot go far with an industrial training unless you first of all provide the foundation of a reasonably good general education. If a boy has not had a general education before entering a workshop, no amount of industrial training can make good the defect. It is generally recognised that the engineer, foreman and chargeman must be educated, but it is equally necessary that the artisan also should be educated though perhaps not necessarily in the same degree.

What then are we to lay down as the minimum general education necessary for an ordinary daily paid artisan; how far must he be educated before he begins to work in a mill or workshop as an apprentice or learner? Opinions on this subject naturally vary, but for the present I think we may accept the general principle that a boy should be able to read and wirte in his own language and be capable of doing simple arithmetic up to multiplication and long division. Some employers, principally those employing European foremen, maintain that he should have a colloquial knowledge of English but all do not insist on that point, and as a starting place I think

we may agree that for nearly every trade a boy should have completed the primary school course in an elementary school.

It does not necessarily follow however that the same curriculum should be followed in each of these schools. With a common foundation composed of the three R's and the remainder of the time-table drawn up with regard to the industries practised in the locality immediately surrounding the school, a reasonably well prepared type should be available for from which most trades can recruit their young operators and mill hands. That is to say a boy if kept at a well organised elementary school until 12 years of age or over, should have sufficient general education to enable him to become an intelligent artisan for most trades. But a lad should not be put to any of the operations comprised in a heavy trade like mechanical engineering until he is at least 15 years of age and therefore sufficiently strong to stand the strain of such work. Moreover for a highly skilled trade like mechanical or electrical engineering, plumbing, or cabinet-making a lad should have a little more general education than is comprised in the elementary school curriculum. His study of the 3 R's should have as a general rule been carried up to the middle or lower secondary school standard but with a considerable portion of his time (a minimum 6 hours per week) devoted to some form of manual training and drawing both freehand and mechanical.

Before completing such a course a lad should be able to work simple equations, plot a simple graph, calculate simple areas and volumes, understand the difference between simple plans, elevations and sections, and be able to use his hands in conjunction with his eye and brain in completing a simple piece of work in wood, metal, or any other suitable medium, from a properly prepared working drawing.

To sum up, the recruits for most trades should have a general education up to primary school standard, the 3 R's being regarded as compulsory subjects in all schools, the other subjects being optional and varying with the needs of the locality; whilst the recruits for specially skilled trades should have a general education up to at least the middle school or lower secondary standard. Their curriculum for the last 3 years should comprise 4 to 6 hours per week devoted to handwork and drawing, whilst the exercises in arithmetic and elementary mathematics should be based on practical and not abstract problems.

So much then for the ordinary artisan; what are we to lay down as the minimum general education for those who aspire to become chargemen and foremen? There is in this Presidency an unfortunate tendency to imagine that foremen can be turned out from technical institutions after a three years course, mostly theoretical, fit and able to take charge of work and direct workmen. This idea has led to much disappointment on the part of passed students and much annoyance on the part of employers. If the young men studying in such institutions would regard their course as purely preparatory, and be prepared to serve an ordinary apprenticeship afterwards they would be on the right lines, and after completing their apprenticeship, would be useful men and well worth employing. In industry there are no short cuts to practical knowledge; a man must practise tool manipulation for a considerable time before he gains that degree of manual dexterity necessary in every skilled worker; and unless a man can do a job himself dexterously, properly and efficiently, he is unfit for foreman or chargeman rank.

An Engineer (Officer Grade) need not necessarily be a dexterous workman if he is a skilled designer and clever administrator, but a foreman must be a skilled workman or he is no foreman. The foreman's value depends on his ability to plan his work so that time and materials are not wasted and to extract the maximum amount of output from every man and machine in his charge. He must know what a fair day's work really represents before he can tell if a man or machine is working efficiently or not, and the only way in which he can possibly tell is to be able to do the job himself. In nearly all workshops the foreman is a promoted artisan. Most of the European foremen and works managers employed in workshops in India are promoted artisans. All marine engineers in charge of engines afloat started as ordinary apprentices, and in the building trade in the United Kingdom and the Crown Colonies, all inspectors of work, masters of works, outside foremen and shop foremen (ranks which correspond to the subordinate grades of the Public Works Department in India), and most building contractors, rise from the ranks of artisan carpenters or builders.

These men have, however, the advantage of facilities at present almost unknown to the Indian artisan. They start with a better general education, generally remaining at school until they are 16 or older. They then serve a properly arranged apprenticeship, supplemented (and this is the crux of the whole question) by con-

tinuation classes arranged for their benefit. By the end of his apprenticeship, a lad working under those conditions has had a good practical training, and in the evening classes has learnt as much if not more theory than the average Indian youth obtains in a three years college course; with the added advantage that his theory has been correlated with his practice and is therefore easier understood and more appreciated. After finishing their apprenticeship courses these youths do not as a rule drop their continuation class work. They keep it up for a year or two while they enter and remain in the ranks of the ordinary artisan until an opportunity occurs for them to show what they can do as "leading hand" in charge of a job, a situation which opens the way to assistant foreman rank, and so on to foreman and works manager positions.

The prospective Indian foreman then must follow in the footsteps of his European colleague. He must start with a good sound education of not less than S.S.L.C., standard with a good grounding in mathematics as his main foundation. He must go through the mill of ordinary apprenticeship and journeyman rank until he shows that he is fit to be promoted to higher things.

II. Industrial Classes.

It may be well to review at this stage what is already being done in the way of industrial education in this Presidency. With the exception of the Leather Trade Institute, the Madras Trades School, and the Madura Industrial Institute, industrial education is limited to that provided in assisted schools. These assisted schools are mostly Christian mission concerns. A few are Muhammadan or Hindu but the principle underlying their foundation is the same. They have been started as charitable institutions to help the individual, and not with any broad idea of developing the resources of the country. Some, nearly all in fact, have been started as a means of providing destitute children with a means of livelihood. The missionary or the charitable Indian wishing to do something to relieve the distress of poor, destitute, or orphan children, opened orphanages or schools for them and later added workshops of different kinds where the boys or girls could work at some trade or occupation until sufficiently expert to earn sufficient for their maintenance.

The practical training provided in these institutions was until recently of a very haphazard nature. In carpentry and weaving in particular low paid *maistries* were employed as teachers and the

boys got exactly the same training in these school workshops as the bazaar carpenter's son or the village weaver's son received from his father. The product was seldom better than the bazaar product and very often much worse. The missionary or Indian Superintendent was satisfied if the lad could earn his living. As charitable institutions, these establishment did very good work but in multiplying the number of inefficient artisans and in many cases spoiling potentially good agriculturists to make poor carpenters or weavers they were not advancing the development of industry to any appreciable extent, and were in fact as little deserving of grant-in-aid from industrial department funds as the village carpenter or weaver teaching his sons and nephews in exactly the same if not more practical methods. Within recent years the managing bodies of these industrial schools have been brought to realise that to entitle them to claim Government grant-in-aid for such institutions, a more intelligent and more efficient workman than the ordinary bazaar product must be turned out. A foundation of general education varying slightly with the circumstances of the case is now insisted on, the course of training is prearranged and comprises a reasonable amount of elementary theory of the principles underlying the different operations performed, and a fair amount of drawing, freehand or mechanical, according to the necessities of the trade.

Working under such improved conditions the schools are producing a type of artisan who is superior to the bazaar product because he can generally understand simple drawings or patterns, can follow instructions in writing and generally can take a broader and more intelligent interest in his work. The schools are moreover turning out a type of workman distinct from the old time village caste workman. The majority are Indian Christians of Panchama descent, a few are Panchamas, a few are non-Brahmin Hindus, a fair proportion are Musulmans, and a very few are Brahmins who are trying a new line away from the traditional literary pursuits of their caste. The majority of these industrial school ex-pupils cannot settle down in competition with the local *achary* workmen, but they find ready employment in Railway workshops, mills and other organised industrial establishments where their previous training in discipline and good time-keeping makes them more popular with employers than the caste workman, who is conservative in his methods, wasteful of time and energy, and continually away from

work for the performance and enjoyment of domestic or religious duties and pleasures.

As long then as the management of these institutions are willing to develop their institutions on the lines of turning out a more efficient artisan than is turned out in the bazaar or commercial workshop, so long will they be entitled to grants-in-aid, but immediately their product falls below the standard reached by the training provided by working in an ordinary commercial establishment the schools are no longer schools but simply ordinary workshops with no more claim to grants-in-aid than other commercial establishments conducted by private individuals for their personal gain. With reorganisation and better staff these industrial schools even with the extra boys enrolled under the provisions of the Children's Act will remain to a considerable extent charitable or welfare institutions rather than aids to the development of industry. A few of them will undoubtedly be considerably improved in the near future and may turn out men sufficiently well educated and with sufficiently good practical training to enable them to take charge of other workmen but as a means of improving the efficiency of the average artisan in the works and mills of the country their influence is not likely to be considerable.

At this stage I do not propose to take up the question of cottage industries like lace work and embroidery. There are many schools teaching these subjects but their problems are different from those involved in dealing with organised industries requiring workshop conditions. Cottage industries deserve a paper to themselves. In the meantime I wish to confine our attention to devising some means of immediately improving the productive value of the large number of apprentices and learners working in mills and workshops all over the Presidency. In time no doubt we will get free and compulsory education, up to the age of 12 or a primary school pass, in this Presidency. When that time comes we will have a better type of recruit to work on but that time is not yet, and we must device some means now for dealing with the boy and girl workers after they start work. Whatever means we adopt can be improved and reorganised to deal with the better educated type of recruit when his or her time comes. In the meantime we have to deal with boys and girls of any age from nine years upwards, and the problem is no light one.

The Carnatic and Buckingham Mills, Madras, have schools for their young workers but smaller firms cannot see their way to such

expenditure and many employers are inclined to say "Why should I spend money to improve workmen for the benefit of my competitors? The money I spend on education, they can spend on slightly increased wages and tempt away my workmen after I have had *the expense of training them." I have considerable sympathy with the employer in this attitude. It is not fair to expect a few public-spirited* employers to bear the burden for all the others and it is only fair, I think, that Government should encourage employers who are willing to experiment with schemes of educational welfare for their young workers. One firm in Madras has recently taken the matter up with very promising results. Messrs. P. Orr & Sons, faced with the necessity of training larger numbers of young workmen in shorter time, have with Government help started classes in the 3 R's and in practical work for a selected number of their young workers. The classes meet on two evenings a week and on Saturday afternoons, and the results so far show that the training of these boys can be, and is being, considerably speeded up.

Where possible of course, such "works classes" should be held in working hours and not after hours, as a lad who has worked all day is admittedly not in a fit condition to study, but in this case neither the staff nor the machinery could be spared during working hours for tutorial purposes, and the experiment is therefore at present being carried on after hours, and also after the boys attending have been provided with a meal at the firm's expense to compensate as far as possible for the extra fatigue. Government are helping the experiment to the extent of half the cost involved and the department is watching the experiment very keenly to note possible developments.

For the present then I consider that most good can be done by developing the "Works-school" idea. That is to say, whilst improving and developing the existing type of charitable or orphanage industrial school as incidental reservoirs of skilled labour, we should wherever possible assist employers to start classes for the young people employed in their works. The whole of the tuition should, if possible, be given in working hours, and where that is not possible the three R's at least should be taught in working hours and the practical work only out of hours. If such classes are properly conducted the management are entitled to apply for Government recognition and grants-in-aid, and provided the classes are conducted in working hours the apprentices attending, if they satisfy the other conditions laid down in Madras Government Order

1481 Revenue (Special) Department, dated 12th August 1920 will be eligible for industrial scholarships together with a bonus if they complete their full course. This Government Order provides for the extension of the present industrial school scholarship system so as to include young persons working in commercial works and mills, and represents an effort to assist employers to keep their apprentices and learners long enough to complete their training, provided the employer on his part is prepared to share in the effort by providing works-schools or classes for the apprentices and learners under training.

III. General Mechanics.

There is yet another type of artisan much in demand all over this Presidency whose training is not quite provided for by an apprenticeship in existing workshops as at present organised. I refer to the general mechanic necessary to look after small power plants which are very numerous in this country. These small plants are mostly rice mills, ginning mills, oil presses, etc. Most of them are badly organised and run on very wasteful methods. They have been erected generally by indifferently trained mechanics, the machinery is, as a rule, badly arranged and scarcely any attempt is made to maintain it in reasonably efficient condition. The engine-driver-cum-fitter-cum-carpenter type of mechanic in charge of the machinery is generally an illiterate workman who has simply worked as assistant to a similar engine-driver in a similar mill until able to convince some employer that he knew enough to look after running machinery. Such men are, of course, quite unfit to be left in charge of running machinery and many mill-owners are now convinced, in some cases after bad breakdowns, that it pays to employ a better trained man if he can be got, even if he costs much more in the way of salary.

The trouble is, however, that the type of man required is hard to find. A trained fitter or turner or smith or moulder even if an expert workman well worth a good salary in an organised engineering workshop is quite unsuitable. What is required is an all-round mechanic who can turn his hand intelligently to almost any branch of a mechanic's work not necessarily with the speed of an expert in that line, but with sufficient intelligence to do running repairs and keep his mill going. He must, moreover, have some training in the elementary principles underlying different

types of prime movers and be able to keep one or more particular types in good running order. He must have some idea of the elementary principles of power transmission and have had some training in adjusting, working, dessembling and assembling rice mill and other local industrial machinery. The demand for such men is very great if not actually acute and in the absence of other provision for training such men it is proposed to try what can be done in Government institutions and in a few of the better organised assisted schools.

A start is being made by reorganising the school section of the Madura Industrial Institute to turn out the type of men required whilst proposals are now being formulated to do something of the same nature by providing special training for a few selected boys in St. Joseph's Industrial School, Trichinopoly. These two institutions will cater for the southern districts, and for the northern part of the Presidency proposals are now being worked out for the establishment of a Government school-cum-mill at Bezwada.

The foregoing pages show what is at present being done in the matter of industrial education in this Presidency and indicate my ideas of what may be done in future. They may be summarised as follows :—

(*a*) More care in selecting recruits and more provision for elementary education.

(*b*) More provision for manual training and other forms of practical education in the middle or lower secondary schools.

(*c*) Provision of preparatory trade schools in large industrial centres.

(*d*) Provision of works schools of all grades from very elementary general education to advanced engineering classes, the classes being held in the works and in working hours; or by the provision of central trades school to provide the same facilities when groups of works are sufficiently close together to make such a system possible.

(*e*) Developing and improving existing assisted industrial schools and Government institutions with a view to turning out all round mechanics for small power plants, and better trained cottage workers.

Items (*a*) and (*b*) come under the scope of the Department of Public Instruction, and a beginning will be made with item (*c*) by attaching a preparatory day school for prospective apprentices to the Madras Trades School, when it is finally housed in its new buildings with its permanent staff.

Item (*d*) is already fairly well provided for in Madras city by the Government Madras Trades School which caters as a central school of continuation classes for apprentices and young workmen employed in the workshops of the city with a branch at Perambar for the Railway works apprentices, and by the establishment as an experimental measure of Messrs. Orr's "works school." When the S. I. R. workshops are transferred to Trichinopoly it is hoped that arrangements will be made to open a school in Trichinopoly on the lines of the Madras Trades School, and when the Harbour scheme develops at Vizagapatam and that port increases in importance, similar proposals will be formulated for the establishment of a school or institute on the land which is being reserved for such a purpose.

Item (*e*) is already being tackled in the Madura Industrial Institute and in the assisted schools, and the Bezwada scheme when it materializes, will complete that part of our programme for the time being.

IV. Action by Local Bodies.

The question yet to be dealt with is, "what can district municipalities and local bodies do towards industrial education?" Local bodies wish to do something and almost invariably their inclination is to start an industrial school. From the inquiries which come into my office it is clear that few chairmen or councillors realise the trouble and expense of conducting such schools. Some of the Christian missions have dropped large sums in trying to conduct such schools, and the only ones that are really successful are those in which a missionary and in some cases two European missionaries give up their whole time and effort to the work. For example the schools at Tindivanam and Kumbakonam have in one case two and in the other, three Europeans as whole-time teachers, whilst several of the others have one trained European employed whole-time in the work, and many of the lace and needle work schools have two or more European lady missionaries employed on full time. The schools are successful only because they are well

staffed at a very moderate cost for salaries. None of these schools could afford to employ teachers so well qualified if they had to pay ordinary market rates for their services. Apart from the European staff of these schools the teaching staff is as a rule indifferent and fit only for employment under skilled supervision.

For these reasons I strongly advise local bodies to pause and consider before proposing the opening of industrial schools. A training section for teachers has been opened at St. Joseph's Industrial School of cabinet-making, Tindivanam, and the supply of trained cabinet-making teachers may be expected to improve rapidly, but the question of suitable superintendents is very difficult. A local body must be prepared to pay market rates and a really efficient superintentendent cannot be got for much under Rs. 500. A superintendent who is not efficient is worse than none at all. When the Government institutions are more fully developed it may be possible to recruit from amongst the junior members of their staffs, after some training and experience in posts as assistant superintendents, etc., men suitable for superintendent's posts, but until then I think that local bodies would do well to consider whether their object cannot be attained, perhaps at less cost, by other methods than by rushing into expensive schemes for establishing industrial schools. When such questions crop up I suggest that the first point to settle is what particular trades or occupations in the locality require skilled recruits for their better development, and how many skilled or technically trained recruits are likely to find ready employment locally, in their trades. A town may for example, have a few tan yards, a few dye sheds or a large number of weavers, whilst in most towns a fair number of wood workers and metal workers find employment. For the council of such a town to conduct an industrial school to teach all these subjects would be a serious undertaking involving considerable expense to the rate-payers. Further, subjects like tanning and dyeing involve training in chemistry and the provision of an expensive equipment. Most towns, moreover, could not readily find suitable employment for more than one or two technically trained tanners or dyers per annum and a school conducted to turn out such small numbers would cost far too much per pupil.

I suggest then, that in such cases, it is far more practicable for a local body to grant scholarships from local funds to a few well-selected young men for study in institutes or schools already orga-

nised and on a firm footing. For example, scholarships of Rs. 40 per mensem for three years might be given tenable in the Government Leather Trades Institute, Madras, for the study of tanning, or in the Victoria Jubilee Technical Institute, Bombay, for the study of cotton weaving or dyeing, whilst small scholarships of about Rs. 15 per mensem if granted to a few particularly suitable boys of good general education up to middle school grade, would be sufficient, with their apprentices' pay, to maintain them during a 5½ years mechanics or woodworkers' apprenticeship in the Government Industrial Institute, Madura.

The most efficient method for local bodies to adopt in dealing with the development of industry is not, however, to start with industrial schools or even with scholarships, but to start at the foundation of the whole structure by endeavouring to provide more facilities for primary and lower secondary school education and by endeavouring to keep that education on as practical lines as possible. If more of the children of the working classes are given an elementary or lower secondary school education, with the optional subjects chosen and taught with some practical bearing on the local industry, and if the existing young workers are given facilities for instruction in continuation classes or work schools, preferably in working hours, but failing that in the evenings, a more lasting improvement is more likely to accrue than can be obtained by tinkering with the type of youth who wants a supervisor's or foreman's post without the drudgery of "learning by doing."

W. FYFE.

SUMMARY OF INDUSTRIAL INTELLIGENCE FOR THE QUARTER ENDING DECEMBER 31st, 1920.

Assam.

General.—This report relates strictly to the quarter ending with the 31st December 1920. There is nothing particular to note regarding general development of industries during the quarter except perhaps the appointment of a Bacteriological Assistant to the Superintendent of Sericulture. Various products of village industries were despatched during the quarter to London for display at the British Industries Fair.

Starting of new industries.—Enquiries relating to the establishment of a paper pulp mill in Assam by certain persons interested in the proposed venture continued but the proposal has not yet taken any practical shape. Owing to the severe depression in the tea market the question of taking up the cultivation and manufacture of natural indigo in Assam has engaged the attention of both Indians and Europeans engaged in the tea industry. The results of the growth and manufacture of indigo demonstrated at Panchnoi on a fairly large scale are most satisfactory. The yield of indigo per acre in Assam is so great that it is claimed that natural indigo produced in Assam will always be able to compete with synthetic indigo. There is every reason to hope that in the near future indigo will reckon as one of our important products.

Technical and Industrial Education.—The Government Weaving Institute at Gauhati was formally opened during the quarter. The School is under the direct supervision of Mr. N. M. Sundram, L.T.M., Superintendent of Weaving, who was formerly in the staff of the Department of Industries, Madras. The School is mainly intended to train a class of demonstrators and a scheme for the establishment of two peripatetic parties, for the present, has been formulated though regular detailed proposals have not yet been submitted to the Local Government. The teachers and some of the students of the School headed by the Superintendent arranged and gave a very successful demonstration of improved methods of weaving, silk reeling, etc., at the exhibition in

connection with the Assam Students' Conference at Golaghat during the puja holidays. There are now four Weaving Schools at Gauhati, Shillong, Tura and Tipkai and two Carpentry and Smithy Schools at Kohima and Shillong. The Local Government sanctioned the project of a school of handicrafts at Sylhet. The school will be opened as soon as the buildings are completed by the Public Works Department.

Experimental and demonstration factories, etc.—Rearing of Mooga, eri and champa silk at the Sericultural Station at Titabar continued during the quarter and fresh seeds of Mooga and eri were issued to rearers from the station while mulberry seeds were obtained from Pusa and distributed to 54 families of rearers. There is now a good demand for eri seeds issued from the farm which yield much larger cocoons of white colour. The Nistari cocoons obtained from Pusa seeds are much bigger than the local *Sorupat* cocoons. Prior to the commencement of rearing house to house disinfection of the rearing houses, trays, etc., were carried out under the supervision of the Sericultural Department staff. Such methods of disinfection were quite new to the rearers. As a result no serious loss occurred through diseases. Encouraged by the satisfactory results the rearers have repeatedly asked for fresh seeds. Arrangements have accordingly been made for distribution of Var Jaune seeds on a large scale during the next month.

Financial and other forms of assistance.—The question of granting a small loan to an enterprising Indian who is running a flour and oil mill with water power in the neighbourhood of Shillong is now receiving favourable consideration.

K. L. BARUA,
Director of Industries.

Bengal.

The constitution of a regular and permanent Department of Industries in Bengal took place during 1920. The Director of Industries was appointed permanently on the 1st of January 1920 and the first question which was tackled was the organisation of the new department along the lines proposed in the report of the Indian Industrial Commission. Prior to January 1920 a temporary post of Director of Industries existed in Bengal, but the appointment was combined with that of the Controller of Munitions, Bengal, and the

work of the latter office was so heavy as to practically absorb the whole time of the officer holding the combined posts. The separation of the work of the two departments took place throughout the year gradually and toward the end of the year the Director of Industries could devote his whole time to the work of the Department of Industries.

Under the Reforms Act the work of the Department of Industries naturally falls into two broad groups, namely, the "Reserved" and the "Transferred." On the "Reserved" side come Factory, Boiler, and Electricity Inspections, the Prevention of Smoke Nuisances and the investigation of Labour Problems; while under "Transferred" fall the Development of Industries and Technical and Industrial Education.

The organisation of the Department of Industries as a whole involved the transfer of Factory Inspection, Boiler Inspection, Electricity Inspection, Smoke Nuisance Inspection and Technical and Industrial Education from various other departments of Government and during the course of the year these transfers have been effected and the offices of the departments so transferred have been unified and absorbed in the office of the Department of Industries.

In addition to the officers formerly engaged on the work of Technical and Industrial Education a Deputy Director of Industries, an Industrial Intelligence Officer and five Circle Officers have been appointed. The Industrial Intelligence Officer at present is mainly concerned with the study of labour problems and in particular with the collection of information relating to strikes. The five Circle Officers have been allotted five areas throughout the province which practically coincide with the divisions of the presidency and these Circle Officers will act as the local representative of the Department and the channels of communication between the people and the Department.

An Advisory Board of business men with wide experience in public affairs has also been formed to assist the Director of Industries with advice on the main questions of industrial development throughout the province. With the transfer of Technical and Industrial Education to the Department of Industries the facilities of the Serampore Weaving School and the assistance of the staff of that Institution are now at the disposal of the Director of Industries and further he has the assistance of the various peripatetic weaving classes which work in association with the Serampore institution.

The organisation indicated above was not completed until the closing months of the year but in spite of that some advance has been made in industrial research, the encouragement of small industries, the collection of industrial information, assistance in obtaining raw materials and coal, and local demonstration of improved machinery and processes.

Research Tannery—A detailed investigation of the tannin contents of the mangroves of the Sunderbans was carried out by Mr. Pilgrim, the Tannin Expert to the Government of India, while on deputation to the Government of Bengal. He has submitted an important and useful report which indicates that in some cases the tannin content of the mangroves of the Sunderbans is fairly high, and, if on enumeration it is found that the distribution is good, the Sunderbans should prove a fruitful source of tanning material. This report is at present in the press and is expected soon, its publication having been delayed considerably by the press strike.

In a separate article in this Journal the work of the Calcutta Research Tannery during the year is described and from that article it will be seen that many processes in tanning involve chemical and bacterial action which are greatly affected by climatic conditions. Before western methods of tanning can be introduced successfully in India careful research has to be undertaken and the article referred to describes briefly the work which has been done in this connection in the Calcutta Research Tannery. It will also be seen from that article that laboratory investigations alone are not sufficient but the results of the laboratory investigations are being applied in the attached tannery and in spite of the delay in obtaining delivery of the necessary machinery for the tannery a considerable amount of success has attended the efforts of the staff towards the solution of the problems undertaken. The chief investigations are being directed towards the production and improvement of tanning materials, the action of chrome liquors in the climate of India, the suitability or otherwise of the water in various parts of India for tanning purposes, the analysis of leather and the giving of information on specific enquiries made by those interested in the trade.

Improvement in Weaving machinery.—So far as cottage industries are concerned the attention of the Department has been chiefly diverted to the improved handloom weaving machinery. In this connection improvements have been made in the fly-shuttle slay, the fly-shuttle loom and the pit-loom and this improved machinery

has been widely demonstrated to the weavers in many places throughout Bengal. The improvements have been received enthusiastically and many 'repeat' orders have been met. Demonstrations have also been made with a "dobby" and an inexpensive take-up-motion adapted to handlooms. At present these have not gone beyond the demonstration stage.

Technical and Industrial Education.—The control of Technical and Industrial Education was transferred to the Department of Industries towards the end of 1920 and the main feature of the year was the appointment of a Committee under the presidency of Sir Rajendra Nath Mookerjee to consider the question of the establishment of a fully equipped technical school in Calcutta. The Committee worked out a scheme covering the main details, chose a site in Calcutta which has since been acquired at a cost of about Rs. 7,00,000 and approved of the plans for the building. The Public Works Department will begin building soon and it is expected that the school will be opened early in the year 1922. The other important development in Technical and Industrial Education in Bengal relates to the question of the improvement of mining education in the coal-fields. This question has been under discussion for a long time and it has now been decided to proceed with the scheme, contributions to the finance of which will be made by the mining interests involved and the Government.

D. B. MEEK,
Director of Industries.

Bihar and Orissa.

In Bihar and Orissa the Industries Department now consists of a Director, a Deputy Director, who is also Industrial Engineer, and a Textile Expert. A Personal Assistant to the Director is about to be appointed. Government have also announced their intention of appointing an Advisory Board of Industries consisting of 10 members with the Director as Chairman but the actual personnel has not yet been selected. Little or no progress can be made with either technical and industrial education or the pioneering of industries, until the financial situation has improved.

In this province the coal bogey at present overshadows everything. Recently supplies has somewhat improved but forecasts for the future are gloomy. Labour has been thoroughly upset by high prices and wandering agitators and in spite of substantial

advances in rates, work is unsatisfactory. The outlook alarms the more timid who tend to remain in their homes instead of returning to work after the harvest. Even if the raisings were adequate, the railways would be unable to supply all demands. The main difficulty so far has been waggon shortage, but it is now generally agreed that the provision of waggons alone would do no good, until the tracks and junctions have been greatly extended. In the Jharia field, owing to the close proximity of the mines, it is doubtful whether the daily despatches of coal can be very greatly increased, at least in the near future, and the chief remedy appears to be the development of the new fields lying to the west.

These conditions hamper both the development of existing concerns and the foundation of new industries. Directors, owners and managers live in daily pre-occupation over their coal supplies and naturally hesitate to launch out into extensions and new enterprises. In spite of this much development has been and is taking place. The extensions at Jamshedpur have often been described. Three blast furnaces are in operation and two more are under construction. The plate mill is now nearing completion and other extensions are well in hand. Of the allied companies the Calcutta Monifieth is nearing production, while great progress has been made with the zinc smelting plant. Sites have been allotted to several other concerns among which Enamelled Iron Ware Ld. and a tinplate company are already commencing work. Two other large iron and steel works are under contemplation and have reached the stage of the acquisition of a site and supplies of coal, iron ore and flux. A large Portland cement works is under construction, and an up-to-date tannery is nearing completion in north Bihar. Much activity has recently been displayed in the extension and improvement of existing sugar mills and the foundation of new ones. In north Bihar, where a number of mills already exist, this has resulted in real progress. But in south Bihar where the area under sugar is greater, many promising schemes have so far failed to materialise. The numerous oil mills, situated chiefly on or near the Ganges continue to flourish for the present in spite of fuel difficulties. The few tanneries, which mainly supply the Indian market, are feeling the depression less than those elsewhere which cater for export. Firebrick and pottery works and engineering concerns have also so far done well, but are now faced with labour difficulties.

Mention has already been made of the labour situation in the coalfields. In the earlier part of 1920 similar trouble occurred at Jamshedpur. Large advances were conceded and for the time being the great bulk of the men seem satisfied. Careful inquiries seem to show that their standard of living has risen and that most of them are able to save money and remit it to their homes. The extra expense is, however, a serious burden to the iron and steel industry and is bound to affect its profits. In other parts of the province labour has on the whole been quiet. A strike occurred at the Jamalpur Loco works of the East Indian Railway last cold weather and a little trouble has recently occurred among the mica workers at Kodarma. But throughout the province employers have granted liberal increases to meet rising prices, while the hours worked tend to contract. It is unusual to find any man, woman or child actually at work for more than 8 hours a day, though in a few concerns 8½ and even 9 hours are the rule. In the mines hours are often much shorter. It seems likely therefore that with a gradual fall in the cost of food and clothing and the spread of education, the standard of living among the industrial population will be greatly improved.

B. A. COLLINS,

Director of Industries.

Bombay.

Throughout the quarter ending 31st December, the Department has been greatly crippled by lack of staff The Director returned from leave in December and is handicapped meantime by the want of an officer who can take charge when he is absent on tour.

2. In industrial engineering, losses, temporary and permanent, have been heavy. Mr. G. H. Thiselton-Dyer, who is the Deputy in charge of this section, has proceeded on nine months' leave. Mr. F. E. Bharucha, who is the only other officer available for doing work in the mofussil, has been engaged for five months in an endeavour to restore to order a dilapidated distillery plant in the custody of the Department of Excise. The only part of the industrial engineering organisation which has been running is the workshops at Dapuri, and even here the death of Mr. A. T. Gosford, who was in charge of the workshops, the appointment, still on a temporary basis, of his successor, and the continued absence of leave of Mr. Holliman, the Works Manager, have hampered development. Mr.

F. C. Davies, who is now in charge, seems, however, to have made marked progress in extending the apprenticeship system, and it is hoped to establish this on a firm basis. One small matter of organisation deserves notice. Three appointments of probationers on Rs. 150—25—200 have been sanctioned, and it is proposed to fill these with men suitable for training into the Circle Officers contemplated in the report of the Indian Industrial Commission. Another serious loss to the Department has been the absence on leave, preparatory to retirement from his appointment as Principal of the Victoria Jubilee Technical Institute, of Mr. Tom S. Dawson who has served the Department in an advisory capacity for the last eighteen months. He and Mr. A. J. Turner, the Acting Principal of the Institute, were responsible for most of the investigation connected with the manufacture of magnesium chloride at Kharaghoda.

3. In chemical investigation, we have temporarily lost the services of Dr. A. N. Meldrum of the Gujarat College, Ahmedabad, who has proceeded on leave after starting a demonstration case in factory at Anand. This is in charge of his assistant, Mr. D. M. Gangolli. During the quarter, Government sanctioned a grant of three scholarships for post-graduate work in chemistry, with the special intention of assisting graduates to undertake or render assistance in technical work.

4. In the pottery section, Mr. E. R. Fern returned from leave only in December. The scheme for the demonstration pottery is held up as it forms part of a large scheme for the developing for industrial purposes of 500 acres of land in the suburbs of Bombay. The duty of developing this area has now been transferred to the new Bombay Development Directorate, but this has had little more than time to settle down in its office.

5. The fisheries section is on the eve of new developments. The services of Mr. A. E. Hefford as Marine Biologist have been secured on loan for two years from the Ministry of Agriculture and Fisheries in Great Britain. A trawler of the Castle type is expected to arrive in February. In fitting the trawler with a refrigerating plant, the Department has had the benefit of investigations carried out in England by the Food Investigation Board which, through its Fish Preservation Committee, has satisfied itself as to the soundness of the brine freezing process both as regards the scientific principles involved and the complete preservation of the fish which results.

6. *Reparation dyes.* There is still a considerable stock of these dyes for disposal. The pricing was a most difficult task and it may be necessary to make changes consequent on fluctuation in the market and the fall in exchange. The dyes are being sold without guarantee, and probably when customers have ascertained their precise quality from experience, the remaining stocks will be taken up more rapidly. Some Directors of Industries expressed dissatisfaction at the short time originally given to them to frame their demands and all have now been informed that further indents will be considered in order of priority of receipt.

R. D. BELL,
Director of Industries.

Central Provinces.

Owing to crop failure and the consequent curtailment of expenditure all schemes for industrial development are at a standstill. Considerable progress, however, has been made by the Textile Expert in the introduction of improved sleys and dobbies, 206 of the former and 135 of the latter having been sold during the quarter. Demonstrations in improved methods of flaying and curing have been given in different parts of the Provinces by the Leather Expert, who has also been successful in introducing a new and improved form of flaying knife.

H. R. CROSTHWAITE,
Director of Industries.

Madras.

In the early months of the year, evidence of the great awakening of interest in industrial development in Southern India which resulted from the publication of the report of the Industrial Commission and the despatch of the Government of India and the Secretary of State on that report, was reflected in the considerable number of new companies that were floated. The conditions prevailing in the quarter under review were, however, very different as owing to the financial stringency, practically no new companies were formed. Judging, however, by the increase in the demand by the public for assistance from the Department during the later part of the year, the decline in industrial enterprise is more apparent than real and when the conditions of the money market become easier it is probable that several industrial projects which are now under consideration

will materialise. This temporary set-back to industrial development may prove in the long run to have been salutary for signs of over development in certain directions were not wanting. The continued rise in the price of machinery and the scarcity and high cost of liquid fuel, continued to restrict development and prevented any marked extension in the work of the Engineering Branch of the Department during the period under review.

2. In accordance with the recommendations of the Indian Industrial Commission, the Government decided to appoint an Advisory Board of Industries to assist the Director of Industries in administration of this department. The orders of Government were received in November appointing a Board of Industries for the Madras Presidency consisting of 12 members. The Director of Industries is the Chairman and Convener and the remaining 11 members are non-officials. A member of the Board holds his appointment for a period of two years. The Assistant to the Director of Industries is the Secretary to the Board.

3. One of the main difficulties which lie in the way of development on a large scale of industries in Southern India is the high price and scarcity of fuel. Numerous discoveries of coal have been made in the Presidency from time to time, the most promising being those made in the Godaveri and Kistna Districts. Coal was actually found by the officers of the Geological Survey in various places in these two districts. In 1917 the then Director of Industries suggested that Government should examine the possibility of finding coal in the Godavari valley. Accordingly Mr. Walker of the Geological Survey Department was deputed to proceed to the area of the deposits in order to fix suitable sites for boring. On receipt of Mr. Walker's report endeavours were made to interest firms and syndicates in the exploitation and development of the field. These endeavours have so far been successful that a leading Madras firm has been granted a prospecting license over 37·96 sq. miles in the Ellore Taluq of the Kistna District and have applied for concession over an area of 135 sq. miles in the Yernagudem taluk of the Kistna District, and over an area of 80 sq. miles in the Polavaram Division of the Godaveri district. The firm proposes to start operations immediately the necessary licenses are granted.

4. The question of a possible Cement industry at Bezwada has been under investigation by the Department for the last three years, and a report on the result of the enquiries undertaken by Mr. Green

was brought to the notice of various financial and industrial syndicates. The endeavours made to interest capitalists in the project will now result in the establishment of this important industry as the Government have recently approved of the grant to a syndicate of rights in certain districts for mining and quarrying the limestone and shale required for the manufacture of cement. One of the conditions governing the grant of the concession is that within four years from the grant of the lease an outturn of at least 30,000 tons of cement per annum must have been attained.

5. A collection of samples of aromatic gums and oleo resins, available in commercial quantities in Madras forests, was made for a large London firm of manufacturing chemists, who were also supplied with full information as to the sources of supply and quantities available. The firm have promised to consider the question of establishing a factory in Southern India for the manufacture of drugs and essential oils.

6. A further development in connection with chemical industries is the contemplated establishment at Vizagapatam, by a leading London firm of manufacturing chemists, of a factory for the manufacture of crude alkaloids principally strychnine, from nux vomica. The firm have already acquired the necessary land at Vizagapatam and will proceed with the erection of the factory at an early date.

7. A Madras firm has applied for a lease over certain quarries in the North Arcot District with a view to quarrying granite. The firm's scheme for developing the quarries provides for the installation of modern machinery and plant for quarrying the granite and as the cost of production will thereby be much reduced, it is probable that the demand for granite will considerably increase. For instance it will probably be used for building purposes in Madras City to a much greater extent than in the past.

8. The subject of the exploitation and development of the deposits of phosphatic nodules in the Trichinopoly District, which are a valuable source of phosphatic manures, with a view to the supply of this manure at cheap rates to the ryots of the delta districts has been under consideration for some time past. It is under contemplation by this Department to establish an experimental factory at Trichinopoly for the production of flour phosphate, and for the exploitation of other minerals such as gypsum and red ochre, which are associated with the nodules.

9. The Industrial Chemist attached to the department is engaged in the following researches in the Indian Institute of Science, Bangalore :—

(1) A study of the indigenous fermentation vat for indigo dyeing.
(2) An investigation into the utilisation of prickly pear. The Industrial Chemist is also engaged on enquiries in connection with the productions of power alcohol and in the preparation of a report on the present position as regards investigations into the suitability of South Indian woods for the manufacture of pulp and paper.

10. The manufacture of inks and vinegar is being carried on at the Government Industrial Laboratory, Coonoor. Other experiments in progress at the Laboratory include the manufacture of casein glue, lacquer for tins, sealing wax, and an investigation into the available sources of pectin.

11. As a result of experiments in the manufacture of glue which were undertaken by this Department, arrangements have been made for the establishment of a small experimental factory in Madras by Messrs. Beardsell & Co., with a view to manufacture on a commercial scale.

12. Other schemes which are under the consideration of private firms or syndicates with the assistance of this department, are—

(1) the manufacture of finished rubber goods,
(2) the extraction of oil from groundnut and gingelly seeds,
(3) the manufacture of pottery and porcelain ware, and
(4) a factory for the production of sugar from cane.

L. B. GREEN,
Asst. Director of Industries.

Punjab.

Every possible encouragement is being given to Hydro-electric development in the Punjab. The Punjab Hydro-Electric and Industry Development Association, Delhi, has now obtained sanction to establish four power houses on the Upper Jhelum and Upper Chenab Canals, namely, Rasul 15,000 B. H. P., Bhimber Weir 10,000 B. H. P., Gujranwala 3,000 B. H. P. and Joyanwala 3,000 B. H. P.

A good selection of samples representative of Punjab industries and more particularly of goods suitable for export trade has been

collected and despatched to London for the British Industries Fair which is to be held at White City, Shepherd's Bush, London, from February 25th to March 10th, 1921. A hall in the Lahore Museum has been secured for a permanent exhibition of goods made in the Punjab and for raw materials with description of processes.

The services of a land surveyor were engaged for surveying possible sites for factories and the survey of certain areas near Lahore has been completed. A detailed list of all prospecting licenses and mining leases has been completed and their positions are shown in a key map on a scale of 1 inch to a mile.

Plans are now complete for the construction and establishment of the Punjab Engineering College at Moghalpura, Lahore. This is intended for the training of mechanical and electrical engineers and will have capacity for 200 students in the elementary course, which will be an essentially practical course, and 25 students in the advanced classes which are intended to equip them for higher grade posts. Actual construction is about to commence. Sanction has also been obtained for the construction and establishment of a Government Dyeing Factory and School and revised plans are now under preparation. A number of weaving schools have now been opened. A weaving institution and school has been opened at Amritsar for 24 students, and schools for 12 students have been opened at Hoshiarpur, Multan, Sialkot and Jalalpur. One Textile Master and six Assistant Textile Masters have been appointed.

Mr. C. A. Shinquin who recently arrived from America has been engaged as Tannery Superintendent to advise on improved methods and plants for tanning. His services will be placed at the disposal of certain tanneries for a few months at a time in each. With a view to the improvement of communications in various parts of the province and more especially the colony areas Mr. MacLachlan has been appointed as Tramway Engineer. He is now engaged in line and traffic surveys.

The Department of Industries has undertaken the issue of a fortnightly periodical known as the "Punjab Industrial Bulletin." Ten numbers have already been issued. The paper has proved of assistance to industrialists throughout the province.

E. A. SCOTT,

Director of Industries.

MISCELLANEOUS NOTES.

Effect of neutral salts on the basicity of chrome liquors :—By B. B. Dhavale and S. R. Das.

Under the above title an article has been published in the September (1920) issue, Vol. 4, No. 9 (225-230) of the Journal of the Society of Leather Trades Chemists. This is a contribution from the Laboratory of the Calcutta Research Tannery, in which the results of an interesting piece of research work in connection with chrome tanning, carried out by Mr. B. B. Dhavale, the Research Chemist, and S. R. Das, Assistant Chemist of the tannery, are recorded.

The principal tanning agent in the one bath process of chrome tanning is a basic chrome salt, either sulphate or chloride, which being absorbed by the pelt (prepared hide and skin) effects the tannage. It has been long observed by practical chrome tanners that the presence of such neutral salts as sodium chloride or sodium sulphate considerably modifies the action of the tanning liquors and although neutral salts are often added in practice to one bath chrome liquor for their beneficial effects on the tannage, the exact mechanism of their influence has not as yet been properly understood. The subject has recently attracted the attention of leather chemists, and some investigations have been made by the American Chemists, Thomas, Baldwin, Wilson and Kern. Thomas and Baldwin showed in a paper published in the Journal of the American Leather Chemists Association (page 192, 1918) that increase in the concentration of sodium chloride in one bath chrome liquor raised the concentration of hydrogenion in the liquor. Similarly Baldwin has shown in another paper (Journal of A. L. C. A., page 10, 1919) that neutral chlorides increase the acidity of chorme chloride solutions. In both these works the change of acidity was measured electrometrically.

In practice, however, electrometric measurement of the acidity of chrome liquor in not usual. The acidity of a chrome liquor is usually determined by the alkalimetric method devised by Procter and McCandlish (J. S. C. I., No. 9, Vol. XXVI) which has become official. Dhavale and Das undertook to note the change of acidity n chrome liquor due to the addition of neutral salts, by measuring

it by this official method of Procter and McCandlish. In the paper under review the effect of sodium chloride has been studied. The chemists intend to carry on the investigation further with other neutral salts as well.

The changes in acidity, which were observed on the addition of varying amounts of chemically pure sodium chloride to a definite volume of one bath chrome liquor of previously determined acidity, will be clear from the following table in which only a few figures out of the many obtained by the authors are given by way of illustration.

Volume of chrome liquor taken	No of c c s of thrice normal solution of sodium chloride added.	Acidity determined by Procter and Mc Candlish's method and expressed in terms of SO_4'' per 52 parts of chromium.
4 c.c.	nil	89·71
,,	5 c c	90·13
,,	20 ,,	91·40
,,	60 ,,	92 39
,,	100 ,,	93·23
,,	160 ,,	94·23
,,	260 ,,	95·55
,,	280 ,,	95·70
,,	300 ,,	95 70
,,	380 ,,	95·70

The figures have been plotted on a curve which indicates that the change is more or less uniform. The figures also show that the acidity increases up to a certain point (corresponding to the addition of 260 c. c. 3 N. NaCl) at which it remains constant even on the further addition of the salt.

While carrying on this investigation the authors had occasion to thoroughly test Procter and McCandlish's method of determining the acidity of chrome liquors. The following main conclusions have been arrived at from this work :—

(1) "Addition of sodium chloride causes a marked increase in the acidity of chrome liquors as determined by Procter and McCandlish's method.

(2) The acidity determined by Procter and McCandlish's method is influenced by the temperature at which the titration is done and the speed at which the alkali is added, but not by the dilution of the liquor under titration."

The Cost of living in Madras.

An interesting paper was read by the Rev. D. G. M. Leith before a meeting of the Economic Association of Madras on the question of the minimum of subsistence for the worker in the city of Madras. In 1917 an enquiry was carried out by a group of young men, chiefly graduates, under the guidance of Dr. Gilbert Slater. Their aim was to work out a standard for the minimum family income sufficient for the physical efficiency of a family. They took the diet prescribed in jails for the adult male person as a basis and reached the conclusion that for a family of a man, his wife and 2 children Rs. 17 should be regarded as the minimum of subsistence. The enquiry summarised by Mr. Leith appears to have been conducted on similar principles. The commodities forming the jail diet were purchased in the bazaar by labourers acting under the directions of the investigators. Separate methods were used to calculate rent, clothing and fuel. The results may be summarised as follows:—

—	1917	1920	°/₀ rise.
	Rs. A.	Rs. A.	
Food for a man, wife and two children	14 0	17 10	26
Rent	1 0	1 8*	50
Clothing	0 8	1 4	150
Fuel	1 0	1 6	37
Miscellaneous	0 8	0 12	50
TOTAL	17 0	22 8	32

It would be interesting to know what relation the wages paid in Madras bear to this figure but it has been alleged that there is a considerable number of people living apparently healthy lives on less than the minimum reached by Mr. Leith. As the methods followed in 1917 and 1920 were virtually the same the conclusion that the cost of living for the poorer classes in Madras has risen by about 30 per cent. since 1917 can be accepted with more confidence.

[* But Mr Leith considers Rs 3 a fair figure for rent. This would make a total amount of Rs. 24]

Safety First.

The "Safety First" movement which started in America in 1907 has obtained an extraordinary hold over those engaged in industry in that country and has become almost a religion with many. The aim of the movement is the systematic prevention of accidents by careful study of their causes, by co-operation between employers and workers and between workers and workers. Striking results have followed the adoption of the movement wherever it has been taken up keenly: some firms have reduced their accident rates by as much as 75 per cent. The movement attracted little attention in England for some years, but the British Industrial "Safety First" Association, which was found in 1918, is now making headway. A conference organized by the Home Office and by the Association was held in London last September, and every endeavour is being made to popularize the movement. Lord Leverhulme of Messrs. Lever Bros. is President and in their works at Port Sunlight, accidents were reduced by 50 per cent. in 1917, by 12 per cent. in 1918 and by an additional 5 per cent. in 1919. For the first half of 1920, there was a further reduction of 20 per cent. as compared with the corresponding period of 1919.

Such figures require no comment and in India, especially, the movement deserves the support of all who are concerned in industry. Messrs. Tata Limited have already joined the Association and other firms are interested. Mr. S. M. Umar, State Electrical Engineer and Chief Boiler Inspector, Bhopal State, has kindly offered to act as Honorary Secretary for India and application should be made to him for literature on the subject.

Bulletins of Indian Industries and Labour.

On the back outside cover of this issue will be found a list of *Bulletins of Indian Industries and Labour* which are, at the time of writing, in the Press. These Bulletins are uniform in size with this Journal, though they are, of course, of varying lengths. The series is intended to serve as a medium for the publication of memoirs that are of interest to those who are concerned with industry and labour. It will be observed that they include a large number of notes on the minerals of India by Dr. Coggin Brown of the Geological Survey who is at present on special duty in the Imperial Mineral Resources Bureau, London. One of these—the note on Bauxite—has been published as

an article in this Journal and it should make the scope of these notes clear. The Bulletin on the International Labour Organisation and the Washington Conference consists chiefly of official documents and includes most of the papers necessary for an understanding of the functions of the International Labour Organisation and of the re-results of the Conference held at Washington in November 1919. It also includes a full account of the conference by Sir A. R. Murray, C.B.E., who was the delegate for the employers of India at Washington. Mr. Clow's Bulletin on the Factory Law Administration gives a brief outline of the history of this subject during the last 50 years and is intended to serve as an introduction to the discussion the new Factories Bill. There has been a considerable demand for the publication of the proceedings of the two Conferences of Directors of Industries that were held at Simla in April last and at Cawnpore in November 1920, and these are given in a handy form in two further Bulletins.

The Editor will be glad to consider original articles for publication in this Journal and will endeavour to return any forwarded to him that are not retained for publication. Correspondence relating to articles in the Journal is also invited. All communications should be addressed to the Editor, Quarterly Journal, Department of Industries, Delhi.

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PRINCIPLES GOVERNING THE GRANT OF MINERAL CONCESSIONS IN INDIA

BY

THE HON'BLE Sir THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., LL.D., F.R.S.

It is the business of a mining company to make as much profit as possible out of a mineral deposit during the period of its mining lease: it is the business of Government to safeguard a national asset of vital importance which cannot be replaced or renewed. But it is better for a country that its mineral deposits should be worked than that they should be left lying idle in the ground. The problem before Government, therefore, or before any large owner of mineral rights, is to frame conditions for the grant of mineral concessions which will ensure a fair return to the State, without undue waste, and yet be liberal enough to attract the investor in mines.

The mineral policy of a Government is thus the choice of a judicious mean between extravagance and conservatism. And as the values of minerals vary with the industrial development of a country and that of the countries with which it is in trade communication, this judicious mean will gradually shift its position between the two extremes. Yet, to attract the investor, stability of policy is also necessary; and thus, whilst the rules for the grant of mineral concessions should be modified from time to time to

safeguard the interests of the State, frequent changes which will unsettle private enterprise must be avoided.

In a country as large as India, a mineral that is workable in one province may be unworkable in another, where fuel may be scarce, means of transport undeveloped or markets unobtainable. Thus, some local variations in the conditions for the grant of mineral concessions may be necessary; yet, because the development of one mineral is often not possible without the simultaneous development of another, the rules should prescribe limiting conditions sufficiently narrow to ensure a judicious degree of uniformity over wide areas.

The whole problem of framing and working a mineral policy for all India is, thus, the choice of a judicious mean in all things —rents, royalties, terms, areas and conditions of tenure.

As justification for *conservatism*, the Government has to realize—

(1) That mineral products are essential for the maintenance of modern civilized activities; when they approach exhaustion, the country will be absolutely dependent on foreign sources.

(2) That a mineral once worked is lost to the country for ever: nothing can renew a mineral deposit

(3) That the miner works only those parts of the deposit that are commercially profitable at the time, often leaving behind far larger quantities of the same mineral in a condition even less fitted than before for profitable exploitation; a mineral deposit which is not worth working to-day may become of great value when processes are improved, or when, through industrial development, local markets become changed.

(4) That, when a company obtains a mining lease, the State, as the owner of mineral rights, goes into effective partnership with the company. The State contributes the mineral deposit as its share of the capital, whilst the mining company provides the working capital. At the end of the lease, when the mineral deposit has been worked out, the State's share of the capital has disappeared, whilst the mining company has secured the profits, and, if successful, has redeemed the whole of its investment. A mineral deposit, therefore, becomes a wast-

ing State asset from the date on which it is leased to an active mining company, and the only compensation that the State obtains for the exhaustion of its mineral deposits is (*a*) the royalty paid, and (*b*) the money spent in local work. As the royalty rates now prescribed in India are rarely more than one-fortieth of the actual mineral values, the return to the State under present conditions is less than the potential value of the mineral; for the royalty is paid on the mineral actually sold by the miner, and not on that left behind through his bad working, or because, at the time, the deposits are locally too poor to be worth exploitation.

The whole process of mineral exploitation is, thus, essentially wasteful: large quantities of rich mineral are left behind for various reasons; larger quantities are damaged by disturbance of the ground in mining; a large percentage of each mineral is lost during the process of dressing for the market or the smelter: and, in the case of ores, a serious percentage is lost in the process of smelting. Finally, the refined product is used in the Arts and, thus, scattered too widely to make it payable to collect again into workable form. A workable mineral deposit is the product of natural processes of concentration which have been going on for geological ages; but the results of these slow processes are undone in a few years by the miner, whose every mistake is irreparable. It has been well said that, whilst the results of bad farming can be recovered and the fertility of damaged land can be renewed, there are no fertilizers for worked-out mines.

As justification, on the other hand, for *liberality*, it is necessary to remember—

(1) That most mining enterprises are highly speculative, and the investor wants the encouragement of generous terms before he will risk his capital in an unproved country.

(2) That most of the capital is sunk in an irrecoverable form: the miner cannot sell underground galleries and shafts in the open market; he must, therefore, hope to recover his capital outlay from profits and that in a relatively short period.

(3) That, unless a miner can now and then reap the benefit of an occasional windfall, he will not be justified in

writing off the losses due to the large number of unlucky ventures which seem to be the constant accompaniments of mining enterprises.

(4) That mineral products are essential to most industries, and it is better to use them even wastefully than to leave so much national capital lying idle.

With these general considerations, mostly platitudes, before us, we can proceed to discuss the way in which they have been utilized in the framing of rules for the grant of prospecting licenses and mining leases in India. It is not necessary to discuss all the details of the rules; this note directs attention merely to some of the outstanding features.

Reason for prescribing All-India rules

In the first place, it is desirable to explain why rules are prescribed for the whole of India, instead of separately for the various provinces. Any serious local variations, either towards conservatism or towards liberality, must necessarily result in local inequalities of development. Minerals cannot generally be worked singly, but in family groups: the chief mineral cannot be developed without a corresponding development of some accessory mineral. Generous concessions, for example, granted for iron ore in one province may be neutralized by difficulties put in the way of mining the essential fuels and fluxes, which may be found only in an adjoining province. Unless, therefore, a mining company is relatively sure that the conditions of mining will be approximately similar throughout the country and in accordance with the published rules, development in a progressive province may be seriously retarded because of conservatism in a neighbour.* Similarly, undue liberality on the part of one province may be embarrassing to a neighbour. A mining company will not undertake a lease for a principal mineral in one province, unless it is morally certain of obtaining fair terms for the accessory minerals in other areas.

Variations in the temperament of local Governments may thus retard the progress of the whole country. Variations from time to time in the same Government may be equally disastrous, and, without the stabilizing influence of general rules, these are likely

* Cf. Report of the Indian Industrial Commission, 1918, para. 227.

to occur; for, every now and then, newspapers devote themselves to some sensational discovery that is assumed to be capable of revolutionizing industries. Most, but not all, of these "discoveries" prove to be illusory, and it is only by having at its disposal a body of high-class specialists that a Government is able to judge soberly of the real commercial merits of these occasional sensations. Through their influence local officials might commit their Governments unwisely, either on the side of liberality or of conservatism. It is therefore advisable to lay down certain limitations applicable to the country as a whole, leaving room for local variations of a relatively minor character, but providing for reference to an independent authority, when special local circumstances suggest the desirability of extending the conditions beyond those prescribed in the general rules. To judge of the wisdom of such exceptions, it is necessary that the independent authority should be in a position to bring together the results of wide experience and should have at its disposal for consultation a body of technical specialists, such as those who constitute the Geological Survey of India.

Periodical revision of the rules

The existing Government of India rules were issued on the 15th September 1913 under a Government order that cancelled the previous rules of 1899. The rules are intended, as already indicated, as limiting guides to the local Governments, working through district officers, who are generally non-technical in training. The issue of guiding rules has the practical value of reducing the number of references that otherwise would be made to head-quarters, without running the danger, either of discouraging mining enterprise or of giving away too cheaply the mineral rights of the State.

But, obviously, the conditions for mining change with the increase of transport facilities, with the development of new local markets, and with the growth generally of industries and technical science. Facilities of the kind that are necessary to encourage enterprise should thus be reviewed at reasonable intervals without incurring any inhibitory effect on mining enterprise. No rules can hold good for longer than a few years, but their revision at frequent intervals tends to unsettle the confidence of business men, which of all bad policies is the worst.

The existing rules were drafted—

(*a*) after consideration of the experience obtained in working the previous rules;

(*b*) after thorough criticism of the draft rules by local Governments, and through them, by the various Chambers of Commerce and Mining Associations;

(*c*) after comparison with the most recent laws in the principal mining countries, including all the self-governing British Dominions; and

(*d*) after reference to the Secretary of State.

The evidence collected by the Indian Industrial Commission shows that, on the whole, the existing rules, from the point of view of the mining investor, are fairly satisfactory.* Most of the complaints made by witnesses were found on examination to be based either on an inaccurate reading of the rules, or were due to their inaccurate interpretation by local officers. The rules are, nevertheless, gradually becoming out-of-date. When they were drafted, for example, iron-smelting had barely been established as a commercial success, whilst steel manufacture in India had so far resulted in failure. It will be noticed that the royalty on iron-ore was thus limited to a nominal charge of half an anna per ton as an encouragement to those who wish to take up iron-smelting During the past few years, however, the success of the Tata Iron and Steel Company has inspired other similar enterprises on a large scale, and the previous encouragement due to a low scale of royalty has been completely superseded by the fact that commercial success in iron-smelting has now actually been demonstrated under Indian conditions. It will be perfectly safe, therefore, to increase the royalty on new leases for iron-ore by two, four, and even eight times without seriously discouraging iron-smelting as a commercial enterprise. Similarly, in other cases, royalty rates were prescribed on the understanding that the mineral, if worked, would be exported in its raw state for utilization elsewhere. But other metallurgical industries, such as, copper, lead, zinc and silver, have become established, with the result that the local market values of their respective ores have increased and are able to pay a higher rate of royalty per ton.

* Report of the Indian Industrial Commission, 1918, para. 223.

The relation of prospecting licenses to mining leases

In the old days shareholders in the Cornish metal mines were generally known as 'venturers.' The name frankly expressed the speculative nature of mining, but the risks of a mining 'venture' can be reduced to legitimate limits by taking the operations in successive stages, each stage justifying the additional outlay incurred in the next successive stage. The facts, for example, obtained from a purely superficial geological survey may justify a more detailed testing of a limited, but still large, area of land by trial pits and borings. This land is thus secured under a prospecting license at a low rental, and, to commence with, for only a year. In other words the State consents to alienate a large area of land for a very short period only.

The prospecting operations conducted during this year may be promising enough to justify the prospector in incurring further expenditure, and he then applies for an extension of his license for another year. He thus commits himself to a limited further expenditure, because his first year of work has confirmed so far the previous results of a purely geological reconnaissance. But he still may not be justified in laying out the capital necessary for systematic mining. On the other hand the State runs no great risk by alienating a large area of land for one year, first, on purely superficial data and then again for another year, when it is satisfied that the prospector is apparently making an honest attempt to prove the value of the land, and is not merely sitting on it on the off-chance of selling his rights to someone else. Similarly, the second year's results may justify a further year of work from the point of view of both parties—the prospector on the one side in laying out more of his or his friends' money, and the State on the other hand in reserving the land for an obviously earnest investor.

But the third year, in the majority of cases, ought to settle the question for both parties—the prospector on the one hand may find that after all the prospects revealed are insufficient to attract the capital necessary for systematic mining; or the State, on the other hand, may think that the prospector has now had a sufficient opportunity, and that the land ought not to be reserved any longer for his special benefit.

The conditions are, however, not the same for all minerals, or even for the same mineral in all areas; and there thus occur a

small proportion of prospecting 'ventures' that necessitate and justify a longer term than a total of three years. But to justify the alienation of mineral-bearing land for any longer period requires the independent opinion of specialists who are able to judge of the merits of the particular circumstances under which an extension of the license is claimed. Thus, whilst local Governments are able to grant prospecting licenses from one to three years, further extensions require the special sanction of the Government of India. The rules are intended merely to cover the average case controlled by the ordinary, local, non-technical officer. They are prescribed so as to grant reasonable opportunities to the average prospector under ordinary conditions, and they thus serve the purpose of preventing frequent references to head-quarters.

Experience has shown, however, that oil-bearing areas cannot generally be tested fully under Indian conditions within the ordinary three-years' limit laid down for prospecting licenses. Drilling to 3,000 or even to 4,000 feet may be necessary to make a fair test of oil-bearing land, whilst satisfactory results from several drill-holes are necessary to justify the capital outlay required for an oil refinery; for in India, crude oil is of little value without a local refinery. The frequent references made to the Government of India for extensions of prospecting licenses for oil beyond the prescribed three years' limit show that it will be soon necessary to make a special standing exception of prospecting licenses for petroleum, and a revision of the rules with this end in view is now under consideration.

The line of demarcation between the conditions of prospecting and those of mining is not fixed and absolute. In the case of some minerals, relatively simple prospecting operations justify the capital outlay necessary for mining operations on a large and systematic scale. In the case of other minerals, prospecting operations will be more protracted, and will merge gradually into mining. Indeed, in a strictly literal sense, prospecting does not really finish until the mine is worked out; for, even under ordinary mining conditions, every wise mine manager lays out money in what he calls development ahead, which is, in reality, a continual process of proving the existence of mineral resources large enough to meet his requirements in the near future. He, for example, distinguishes between ore blocked out, which he is quite certain of, and ore

partly proved, which he regards as a reasonable probability of prospects ahead.

The essential distinction between a prospecting license and a mining lease can, however, be summed up in a sentence. Under a prospecting license a large area is granted for a short period at relatively low rates; under a mining lease a small area is granted for a long period under terms calculated to bring reasonable returns to the State. The conditions laid down in the rules must necessarily be arbitrary, and only approximately suitable to most minerals; for the rules have to be worked by local officials who have no special expert knowledge or experience.

Although local Governments can grant prospecting licenses up to a total of three years, the rules provide for the grant of this total in instalments, which in the aggregate exceed the original term. This system of granting extensions of the prospecting license by yearly instalments is adopted as a safeguard against those persons, small in number, but inconveniently numerous, who, through means other than those ordinarily classified as technical, get ahead of the serious worker in lodging a claim, and so secure the benefit of the rule which gives a prior right to the first applicant who conforms to the conditions laid down (*see* summary of rules below). Obviously, many new dangers would be incurred if local officials were given power to discriminate between the merits of different applicants, and the rule of priority is thus the only one that can safely be used under normal circumstances.

Nevertheless, there are persons who secure certificates of approval, and, yet for various reasons, have not the power to turn a prospecting license to real account. They thus take up licenses in the hope of disposing of their rights for a consideration to serious and competent workers. If such persons were granted straight-off prospecting rights for the full three years, they might become in effect parasites on recognized mining companies; or alternatively, they would be the means of preventing the development of mineral land for inconveniently long terms. By granting a small term in the first instance the activities of such persons become limited; for extensions are not granted unless the local officials are satisfied that a definite effort is obviously being made to prove the mineral value of the land; nor are extensions refused lightly: the presumption s in favour of the prospector already installed.

Obviously, a prospector does not spend his money for mere amusement. He hopes, on the discovery of valuable mineral deposits, to have the privilege of recovering his capital outlay through profitable mining operations. Consequently, a prospecting license carries with it a claim for a mining lease over a reasonable fraction of the area licensed.

Certificates of approval

Under the old rules, local officials were expected to make an enquiry into the financial competence and *bona fides* of all applicants for prospecting licenses. These enquiries were found often to be futile, and they always resulted in considerable delays. Strictly enforced, the old rules were liable to do harm without a more than corresponding amount of good; so when the new rules were framed, it was decided to liberalize the system for the grant of certificates of approval. But safeguards were at the same time introduced by making these certificates valid only for the remainder of the calendar year. If during that period it was found that a certificate holder was not a genuine prospector, his certificate would not be renewed, and his oportunities for securing further prospecting licenses would thus be ended. He might, of course, have secured a license meanwhile; but, again, that license would last for a year only. Thus, the dangers incurred by the more liberal system of granting certificates of approval are small compared with the harm that would be done by hampering the activities of competent individuals and firms.

Security deposits

Applicants occasionally grumble because they are required to deposit a small security, and they sometimes state that this merely ties up money which might otherwise be devoted to developing the land. The security, however, is not necessarily a cash deposit; it may be in a form which enables the applicant to draw interest on his money. Experience has shown that some such precaution is a necessary one, and it becomes no real hardship to a firm otherwise competent to follow up its privileges with capital outlay on the scale necessary for serious operations.

Rents

In the case of prospecting licenses, the annual surface rent prescribed by the rules varies between one rupee as a maximum and one anna as a minimum per acre. Both maximum and minimum limits are necessary—in the one case to prevent a local official from inadvertently discouraging prospecting operations, and in the other case, to ensure that an applicant for a prospecting license will not take up land frivolously or without due discrimination. Where the mining industry is more thoroughly developed, it may be safe to increase these rentals, and, indeed, in some countries the imposition of a high rent is regarded as the best of all safeguards, forcing the applicants to take up land only after obtaining the best technical advice. The conditions are not yet ripe in India for the imposition of anything greater than a comparatively small rental.

Similarly, under a mining lease a reasonable dead rent is required to ensure that the land is worked effectively after the first year, for the dead rent so prescribed becomes absorbed by the royalty paid on the mineral raised and sold.

Royalties

A mineral varies in value according to its situation with regard to its market: it may be marketable in the raw state, in a concentrated form, or only after refinement and smelting. Thus, besides the ordinary facilities for mining operations, the local pit-mouth or so-called 'spot' value of the mineral will depend on the transport facilities to a market, the local facilities for concentrating operations, or the possibility of obtaining the fuel and other accessory materials for actual smelting. Similarly, the value of a mineral will change with the industrial development of the country. Mineral products exported in the raw state from an undeveloped country obtain increased local values when local markets become developed. The royalties laid down in the all-India rules are, thus, generally prescribed as a percentage of the local value of the mineral; but, for the convenience of payment during the currency of a particular lease, it is usual to translate the percentage rates into so much money per unit weight of mineral, reserving the right to alter the rate for specified terms so as to keep approximately near the prescribed percentage of the 'spot' value of the mineral. In

an undeveloped country the State loses money by taking only that royalty from minerals due to their locally low 'spot' values. The development of industries, especially the chemical and metallurgical industries, thus returns directly additional revenue by increased royalties, apart from the economic value following the displacement of expensive imported chemicals and metals.

Summary of the Rules for the Grant of Prospecting Licenses and Mining Leases in British India *

Rules 3 and 6

Any British subject is at liberty to search for minerals in unoccupied and unreserved land which is the property of Government; but, before obtaining a prospecting license or a mining lease, which carries with it certain privileges, he must obtain a **certificate of approval** from the local Government within whose jurisdiction the land lies for which the license is required. A certificate of approval, which will hold good till the end of the calendar year, can be obtained for Rs. 50 and, if the local Government approve, can be renewed for a fee of Rs. 10

Rules 7—9

Rules 16—18

The applicant for a **prospecting license** is required to furnish a description of the land, illustrated by a map or plan, or alternatively, to peg out his claim according to a prescribed system, and when two or more applicants apply for the same land, the prior right to a license, other circumstances being satisfactory, shall be deemed to lie with the applicant who first files his application with the Collector of the District.

Rule 23

Rule 24
Rule 26

Before a license is granted, the applicant must deposit either Rs. 100 per square mile or part of a square mile, or give security to a like amount. The license must then be executed within three months.

Rule 27

A district register of licenses granted is open to inspection by any holder of a valid certificate of approval on payment of a small fee.

* Resolution of the Government of India, Commerce and Industry Department, No. 7562-7581—[illegible], dated 15th September, 1913, and subsequently amended.

A license is granted in the first instance for not more than one year, but may be renewed for a further term not exceeding two years.

Rule 30 (i)

The licensee has to pay a fee not exceeding one rupee and not less than one anna per annum per acre of the land taken up, and is required to pay royalty at a rate not exceeding 15 per cent. of the value on all precious stones that may be obtained, and, for other minerals, over and above specified small quantities allowed free, at the rates referred to below for mining leases.

Rule 30 (ii) and (iii)

The licensee requires the previous sanction of the local Government to transfer his rights to any other person holding a certificate of approval.

Rule 30 (vi)

Within six months after giving up his license, a licensee may be required to restore or to make safe any land opened up during his prospecting operations.

Rule 30 (viii)

Each license carries with it the right to claim a mining lease in accordance with the rules, the lease comprising the whole or a part only of the area covered by the prospecting license, so long as the total area leased does not exceed ten square miles within any one province.

Rule 32

Before obtaining a refund of his security, a licensee may be required to disclose confidentially to Government any information obtained as to the mineralogical or geological nature of the area licensed.

Rule 33

In the case of **mining leases,** the applicant is required to deposit as security the equivalent of not more than Rs. 500, but any sum already held in deposit in respect of the prospecting license will be carried forward to the applicant's account.

Rules 36—37

The application for a mining lease must be accompanied by a map or plan showing the boundaries of the area applied for; or alternatively, the ground may be marked out as in the case of prospecting licenses.

Rules 38—40

In the case of two or more applications affecting the same land, not already held under a prospecting license, the rule of priority holds.

Rule 42

A register of mining leases is kept in the Collector's office for inspection by holders of certificates of approval or their representatives on payment of a suitable fee.

Rule 43

No mining lease shall be granted by the local Government so as to cause the total area held under mining leases by the lessee or by those joint in interest with him to exceed 10 square miles within the territories administered by the local Government; but the Government of India have power to grant areas in excess of this amount.

Rule 45

Without the previous sanction of the Governor-General in Council, or unless provincial rules are prescribed for special conditions, such as river dredging concessions, the length of an area granted under a mining lease shall not be allowed to exceed four times its breadth.

Rule 47

The boundaries below the surface of all areas given out on mining leases are regarded as running vertically downwards.

Rule 48

The term for which a mining lease may be granted shall not exceed 30 years, but the lease may contain a clause permitting renewal for another 30 years on a dead rent and surface rent not exceeding twice the original rents, the royalty payable being that which on the day following the expiry of the original lease shall be the royalty rate then in force.

Rule 49

A lessee, with the previous sanction of the local Government, can transfer his rights to another person or company holding a valid certificate of approval.

Rule 50 (vii)

Unless prevented by reasonable cause, a lessee is required to commence operations within one year from the date of the execution of his lease, and is thereafter required to carry on the operations effectually in a proper, skilful and mining-like manner. If a lessee, without reasonable cause, ceases to work the mine for a period exceeding two years in such a manner as to produce sufficient mineral to earn a royalty at least equal to the dead rent, he will be liable to forfeit his leasehold rights, or may be required instead to pay a higher dead rent not exceeding twice the original rent.

Rule 50 (viii)

A lessee is required to keep correct accounts showing the quantity of all minerals obtained, the number of persons employed, as well as plans of the mine, for Government inspection. He is required to allow existing and future adjoining licensees or leaseholders of land to have reasonable facilities of access thereto; and is also required to report the discovery of minerals other than those specified in his lease.

Rule 50 (ix)—(x)

Rule 50 (xii)

At the determination of his lease, he is required to deliver up the premises in a proper and workman-like state to the satisfaction of the local Government.

Rule 50 (xv)

Any lessee is at liberty to relinquish his lease at any time on giving not less than twelve calendar months' notice and on payment of all sums that may be due, and cannot take a new lease for a portion of the land so relinquished.

Rule 54

The **royalty rates** prescribed by the rules include 5 per cent. on the sale value of ordinary coal, with a minimum of 2 annas per ton, and half these rates for coal dust. In the case of mica, the royalty is 5 per cent. on the sale value at the pit's mouth. For oil, the royalty is 8 annas per 40 gallons, or 5 per cent., *ad valorem* on the gross value; and for gold and silver, the rate paid is 7½ per cent. on the profits of each year taken separately, or 2½ per cent. on the gross value of the metal: Iron ore has hitherto been charged at the rate of half an anna per ton. Lease-holders for precious stones pay 30 per cent. on the net profits of each year taken separately; and for all other minerals, not specified above, the rate is 2½ per cent. on the sale value at pit's mouth, convertible at the option of the local Government to an equivalent charge per ton to be fixed annually or for a term.

Schedule A

Lease-holders are required to pay a minimum **dead rent,** which becomes absorbed by royalty. The minimum rates charged are four annas per acre for coal, lignite and minerals used in agriculture and chemical manufactures, such as bauxite, gypsum, iron pyrites and pyritous shales. For gold, silver and precious stones, the minimum rate per acre is one

Schedule C

rupee, and for iron ore one anna per acre. These minimum rates are liable to be exceeded according to the value of the deposit and the degree of the development of the area.

Schedule D

The annual **surface rent** charged for land actually occupied under lease is that assessable under the revenue and rent law of the province, or, if no such rent is so assessable, the rate may be fixed by Government, subject to a maximum of one rupee and a minimum of four annas per acre.

T. H. HOLLAND

THE RAJPUTANA SALT INDUSTRY

BY

P. C. SCOTT O'CONNOR,

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The whole of the tract of country known as Rajputana is, generally speaking, saline in character. Most of the deeper wells are brackish, and in the summer months the water in certain areas is undrinkable. The people depend largely on rain-water which is conserved in tanks or stored in small reservoirs constructed underground. For a few months after the rains, however, fresh water in small quantities is to be had a few feet below the surface, and this is obtained from shallow holes dug in the sand.

All the natural depressions in the country are capable of producing salt. The most important of these is the salt lake at Sambhar which is the largest of its kind in India. It lies at an elevation of 1,184 feet above sea-level. In shape it is somewhat oval, with a length, from east to west, of about twenty miles and a breadth varying from two to seven miles. On the west it is bounded by the Aravali range of hills; on the other sides there are vast sand plains. In area it is about ninety square miles. The bed slopes very gradually to the centre, where the depth, when the basin is full, is about four and a half feet. A little over one hundred years ago the water stretched for fifty miles, and there is no doubt but that the two depressions in the neighbourhood, known as the 'Nallia Sur' and the 'Julga,' which are now separate lakes, were at one time merged in the great lake.

Local tradition ascribes the formation of the lake to the gift of the goddess Sakumbri Devi, the tutelary goddess of the Chauhan Rajputs, who, in return for milk supplied to a religious ascetic in A. D. 551, converted a forest into a vast plain covered with gold and silver. As the inhabitants of the locality regarded the gift more in the light of a curse than a blessing, fearing it would excite the cupidity of the neighbouring clans, the

goddess turned the precious metals into salt which the rain dissolved and washed into a natural hollow, thus forming a lake. It is a pretty story and one that is still credited by the simple-minded Rajput folk. In 1870, when we finally took over the administration of the lake, a peculiar incident occurred which greatly excited the people, as they thought we had discovered the means of winning back the original gift of the goddess. The Government chemical analyst, in search for a little pure silver, converted some metallic silver into chloride of silver, and, mixing this with some borax to act as a flux, placed the whole white mass in a crucible and made it over to a village goldsmith to be reduced to its metallic form. When a sufficient degree of heat had been reached, the workers were astonished to see molten silver in the crucible. The *rationale* of the process had to be explained to the local state officials and the leading men of the town before they would be convinced that there was no magic about it.

Science teaches us that the large majority of the salt lakes of the world have been formed, either by isolation of bodies of sea-water or by the solution of rock-salt or by the combination of the two. Good examples of these processes are the Dead Sea, and the Bitter Lake in the Suez Canal; but there are other lakes, such as lake Oroomiah in Persia, which are formed by rain-water and streams dissolving effloresced salt and carrying the brine into natural basins, which, having no outlet, concentrate by evaporation. In regard to the Sambhar lake, it was thought at one time that the formation of the depression and the salinity of the water were caused by subterranean rock solution; but borings have failed to show any trace of rock-salt underlying the bed of the lake, nor is there any evidence of such salt anywhere in Rajputana. The theory, therefore, that the salt in the lake is derived from the denudation of the rocks of the surrounding country which were once assumed to belong to the Permian system, a system abounding in limestone and salt, does not appear to be the correct explanation. It was also conjectured that, at some past period of the world's history, the sea receded from the present sandy wastes of Rajputana leaving the soil impregnated with salt, which was gradually washed by rain into the natural depressions in the country. As millions of tons of salt have been taken out of the lake in the past, and spontaneous or naturally-formed salt is no longer obtainable, it was thought that the supply of salt was becoming exhausted;

but investigations made by Sir Thomas Holland and Dr. Christie show that there has been no appreciable diminution of the stock of salt, which is sufficient to meet all demands for a practically unlimited period; and, moreover, that the supply is being contributed to from year to year by dust salt brought in by the summer winds from the sea. The disappearance of spontaneous salt is due entirely to the inflow of silt which has buried a large part of the bed of the lake.

In a paper "on the origin of the salt deposits of Rajputana," published in the Records of the Geological Survey of India in 1909, Sir Thomas Holland wrote:—

"Investigations have shown that the salt resources of Sambhar are confined to a body of saliferous silt, stretching over an area of 80 to 90 square miles and attaining depths in the centre of 60 to 70 feet. The analyses made of samples taken at regular intervals over the lake-bed show that in the upper four feet of silt, over an area of 63 square miles, there is an accumulation of more than 18,000,000 tons of salt." In regard to the salt blown in from the sea, it is stated that it is "brought in in the form of fine dust by the strong south-west winds that blow across the salt-encrusted region of the Runn of Cutch during the months of April, May and June of each year," and that in the monsoon "the finely divided salt dust that may have reached the heart of the desert is washed into the hollows occupied by brine lakes."

The upper two feet of the bed of the lake are composed of black fetid mud, giving off sulphuretted hydrogen, derived from the decomposition of animal and vegetable matter, which is the cause of the characteristic and unpleasant smell often noticeable.

The lake has no outlet, but there are four streams—the Menda, Rupnagar, Kharian and Khandel—which flow into it. These streams, with their tributaries, drain an area of no less than 2,200 square miles: consequently, in a year of heavy rainfall, such as 1917, when the fall measured over forty-one inches as against an average of twenty inches, the lake fills to over-flowing. In the early summer months, when the lake is dry, the glare and heat are intolerable, and the whole country presents a picture of the greatest desolation; but during the rains a marvellous change takes place. The scenery then is exceptionally fine, and the sunset effects are the most gorgeous I have witnessed on the plains of India. Particularly interesting

is a visit on a breezy moonlight night to the embankment which guards the salt works from the main body of the lake. The heaving mass of water, the sparkling, foam-crested waves, the boom of the surf, the smell of the air, all remind one of the sea, and, as one gazes westward, visions of white cliffs emerge from the background of the sky.

The lake lies within the boundaries of the States of Jaipur and Jodhpur. The western half is owned by Jodhpur, while the eastern half is owned jointly by the two States. The population in the neighbourhood is sparse, owing to the sterility of the country, but there are two towns, Sambhar and Nawa, with a population of about 12,000 and 5,000, respectively, situated on the shores of the lake itself. The lake was worked by the Emperor Akbar and his successors up to Ahmad Shah, when it reverted to the Rajput Chiefs of Jaipur and Jodhpur. From 1835 to 1844 it was worked by the Indian Government to repay them for compensation due and expenses incurred in repelling the predatory raids of the Rajput tribes in British India. On the 1st February 1870 it was leased to the Indian Government, since when it has remained under our administration. The principal object which Government had in view in obtaining a lease of the lake was to increase the supply of salt and reduce its price in the United Provinces of Agra and Oudh by providing skilled supervision and improving communication between it and the markets. Prior to its acquisition by the Indian Government, the Salt Department of Northern India, then known as the Inland Customs Department, was not concerned with the manufacture of salt. The great Customs Line—a chain of posts, 2,472 miles in length—stretched across India from Torbela on the Indus to the Mahanadi, in the Central Provinces, and duty was collected at the *chaukis* on the line on salt coming up from the Rajputana sources, destined for British India. By 1878 the Indian Government had assumed the management of the remaining sources in the Jodhpur State, and had negotiated treaties with all the other Rajputana Chiefs within whose territories salt was being manufactured, enjoining the closure of the works, on payment of compensation, or the restriction of the outturn at works left open under the managements of the Darbars. Duty was now levied at the sources and the Customs Line abolished. The sums paid under these treaties to the Darbars, including the payments made for the Sambhar lake, amount, to nearly thirty lakhs of rupees a year,

and some of the principal States also receive a fixed quantity of salt yearly, either free of price and duty or on payment of half the duty only.

In the early years of our management, the Sambhar lake had not the importance which it now possesses as a source of supply. The average quantity of salt annually manufactured during the six years from 1870-71 to 1875-76 was 16,56,956 maunds, whereas the average quantity put up during the past six years was 55,63,265. The greatest quantity manufactured in any one year was 1,11,90,738 maunds in 1918-19. Since 1870 the lake has yielded over twenty crores of maunds of salt. Sambhar salt is in general use throughout Rajputana and is extensively consumed in the United Provinces and Central India. Lesser quantities are exported to the Punjab and Bihar. During the war, when the supply of imported salts fell off, the demand for Sambhar salt from Bihar rose considerably and some was also sent, for the first time, to Bengal. Now that foreign imports have increased, the demand from Bengal has practically ceased, while the exports to Bihar have fallen to about one-fourth of the war-time demand; but the quantity is still about five times as much as in pre-war times.

In the dry, hot air of the desert evaporation is rapid, and within a few months after the rains, in a year of normal rainfall, the waters of the lake contract and gather towards its central and deeper parts, where, after further evaporation, a wide bed of spontaneous salt is exposed to view. Owing, however, to the belt of soft mud by which this salt is surrounded, it is impossible, except at a prohibitive cost, to gather it and bring it to store. Spontaneous salt is, therefore, no longer gathered, and all the salt now obtained from the lake is manufactured. Salt is won by two methods: from permanent salt works constructed in the bed of the lake and called *kyars*, and from shallow pans of a temporary nature constructed on the lake shore. The former are worked by the Department and the latter by contractors. A *kyar* is a large rectangular enclosure divided into pans and protected from the lake water by high embankments pitched with stone. Alongside the *kyars* are platforms for the storage of salt and reservoirs for brine. Before the monsoon sets in, the mother-liquor (otherwise known as 'bitterns') which is the concentrated residual brine from which the salt has separated, is pumped out of the pans, which

are then cleaned and prepared for the following season's crop. As soon as the rains have ceased, the sluice-gates of the reservoirs, which have been left open during the monsoon for the admission of brine, are closed, and as much extra brine as the reservoirs will hold is pumped into them. If the rains have been heavy and the *kyar* pans are flooded the excess brine is pumped out, while if they are not full enough brine is added. In a normal year the brine in the pans, after the rains, has a density of about 10° Beaume, and it is the object of the manufacturing officer so to keep his pans supplied with brine as to have a depth of twelve inches when the density has risen by evaporation to 25° B. This will leave him about four inches of brine when the density has reached 29° B. or 30° B., when extraction of salt begins. This depth of brine is essential to keep in solution the magnesium and other undesired salts which may be present and is also required for the washing of the gathered salt.

The lake brine is a complex solution of sodium chloride, sodium sulphate, sodium carbonate, calcium carbonate, and a trace of magnesium salts. Now, the object of the salt manufacturer is to extract the sodium chloride as free from the other salts as circumstances will permit. To enable him to do this it is necessary that he should not only be acquainted with the various salts in the brine but should also study their behaviour and mutual reactions in solutions of various degrees of concentration at different temperatures. An instrument, known as Beaume's hydrometer, designed to show the density of fluids, will tell him how the evaporation of his brine is progressing and what changes are taking place in it; but, as the presence of other salts in the brine affect its reading, experience alone will enable him to correct the error in practice, and visual examination of the salt crust, from day to day, will help him to decide when to begin extraction and when to stop it. Further, it is imperative that he should observe closely all changes in the weather, as such changes materially affect the quantity and quality of the salt manufactured.

The extraction of salt at the lake is done entirely by manual labour. As soon as the salt has formed, labourers—men, women, and children—enter the pan and gather up the crust into small heaps. Some skill is required in this operation to avoid taking up

the mud on which the crust lies: After the heaps have been thoroughly washed with residual brine and allowed to dry, the salt is carried in baskets, by headloads, and in bags on buffaloes, to the storage platform, where it is built up into conical and oblong pyramids, sloped to an angle of 36°—the angle of repose for granular, loose salt—and containing from 50,000 to 1,00,000 maunds each. These heaps are beaten and smoothed as a protection from rain, but not covered. The wastage amounts to about three inches of surface salt per annum. Formerly payment was made on estimation at the close of the day's work to each labourer separately for the salt he had put up. This necessitated the making of innumerable little heaplets on the storage platform preparatory to the removal of the salt to the main heap Now a very much better system has been introduced and has resulted in a considerable saving of time and energy to all concerned. A contractor has been appointed, and the labourers are paid by him for each basket of salt as it passes his overseer on its way from the pan to the main heap, the contractor himself being paid on the estimated contents of the main heaps, payment being made fortnightly.

If extraction is begun at the right time and all dirt and insoluble matter washed or picked out, Sambhar *kyar* salt is of excellent quality. The crystals are large, hard and white. Representative samples have on analysis been found to contain over 99 per cent. of sodium chloride.

Pan salt is made by private contractors in shallow pans on the shores of the lake. These works are of a temporary nature, constructed each year after the monsoon. Brine is obtained from wells dug in the bed of the lake. The produce is white and of fair quality, but, as the crystals are small, due to the shallowness of the pans used, this variety is not much in favour with traders as it loses weight in transit.

Twenty years ago there were eleven *kyars* at the lake, covering an area of about 736 acres; but two more *kyars* have since been constructed and it is proposed to add another. As the labour formerly employed by pan contractors is now employed in the *kyars*, the manufacture of pan salt is fast dying out.

The cost of production is about 1 anna and 2 pies per maund of *kyar* salt and 7½ pies per maund of pan salt. These figures include the cost of upkeep of works and interest on capital sunk.

The salt is sold at the source at a uniform price of four annas a maund, and the duty is Rs. 1-4-0 a maund.

As will already have been noticed, the manufacture of salt at the Sambhar lake is dependent to a large extent on the monsoon rainfall. Given favourable conditions, no more than two crops of salt can be obtained in a season with the existing plant; but, as even this quantity is barely sufficient to meet the demand, the difficulty experienced by the Department when the monsoon fails can easily be imagined. Some years ago, when spontaneous salt could no longer be obtained at a reasonable cost, the works were enlarged by the addition of two *kyars*, and canals were constructed in the bed of the lake for the supply of subsoil brine; but the latter have not proved a success as they silt up very rapidly and cost a great deal to keep in working order. Moreover, the salt produced from such brine is inferior in quality.

Before the war little, if any, effort was made to develop the sources and push sales. Times, however, have changed, and what satisfied us yesterday does not satisfy us to-day. The services of technical experts have been secured, and the aim of the Department now is, not only to meet the present demand but to win new markets for its produce. There is no reason whatever why India should not produce all the salt she requires. With so extensive a seaboard and such vast deposits of salt as are found inland, and an ideal climate for manufacture, she ought not to have need of large imports of foreign salts. Nature has equipped her admirably with the means, and she is in a position to supply the requirements of her teeming millions without outside help.

Schemes for the thorough development of the sources have been worked out by experts. Some of these have, in whole or in part, been sanctioned, while others have been postponed owing to financial stringency. At Sambhar a large reservoir—a long-felt need—is under construction. The comfort and welfare of the workers are receiving attention; and labour settlement, with comfortable quarters and a good water supply, is nearing completion. A new *kyar*, a central store, an efficient pumping plant, an electric installation and mechanical transport—all parts of the main scheme—are yet to come. These works will cost a substantial sum; but the money spent on them will be repaid several times over in a very short ime by the profits that will accrue.

Provided, then, that the money required is sanctioned the Department will in a few years be in a position to turn out salt of the finest quality in greatly increased quantities.

P. C. SCOTT O'CONNOR

THE HYDRO-ELECTRIC SURVEY OF INDIA

BY

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At the present time, as a direct result of the war, the whole world is examining its water power resources while endeavouring to conserve its fuel resources. Even Great Britain, once the stronghold of cheap coal, is turning eagerly to the rival claims of white coal. India, which has no intention of being left behind in the revival of trade which must follow the present reaction, is carefully taking stock of her industrial possibilities; and amongst other matters a hydro-electric survey has been at work for two years.

The prime sources of power

The sun is the *ultimate* source of all power on the earth, although the direct utilization of its energy has scarcely reached beyond the experimental stage. Excluding animal power—still used to a vast extent in India—fuel (*i.e.*, wood, coal and oil mainly), wind, and falling water are the main agents by which solar heat is transformed to mechanical or other forms of energy. Wind power, although largely used for water pumping, need not be considered further here, but the friendly rivalry of fuel and water power must be considered for a proper understanding of the subject. Fuel may be used for producing power, either by combustion under boilers, which supply steam to steam engines and steam turbines, or by direct internal combustion in the cylinders of gas or oil engines. Falling water has been used for centuries to drive water wheels, including the primitive types found on every perennial hill torrent in India, mainly for grinding corn or similar uses. Until electrical transmission enabled it to be utilized at a distance from its source, but little progress was made in other directions. Consequently, the world's industrial development depended, until recently, upon fuel through the agency of the steam engine, the steam turbine, and the oil or gas engine. Re-

cently the advances in electrical transmission have enabled progressive countries to develop their water power. Fuel supplies are not unlimited, and unless the factory is brought to the coal or oil field the fuel must be carried to the factory—or at least within reach of transmission of power. Unless the facilities for such carriage are exceptionally good it is found more economical to transmit the power than to carry the fuel. It is now established that for long distances electricity is the only practicable method of transmitting power. There are losses in any case, whether in the form of actual power wasted in heat, or of annual capital charges, or of freight.

Tidal power

The recent booming in the Press of the great scheme for a barrage on the River Severn, costing some thirty millions sterling, has awakened an interest in tidal power: indeed it has seldom slept, for inventors are never tired of producing paper schemes for its utilization. It is perfectly true that enormous stores of energy are unutilized in the tides; but, apart from their periodic nature, their development would in most cases cost far more than would suffice to provide the equivalent power by other means. Possibly hereafter as fuel becomes scarcer and even more expensive, tidal power may be able to pay its way; at present it can not. Leaving this branch of the subject to the cranks, there are three, and only three, clearly defined cases in which water power can be developed on sound lines.

What water power means

In a water wheel of the ordinary overshot type the water flows into a series of buckets fixed upon a wheel, and the weight of the water falling down carries the wheel round and gives power on the shaft; it is exactly the reverse process to that of the ordinary 'Persian wheel,' where the power of a man or an ox revolves a wheel and draws a quantity of water up out of a well. Clearly the power given or required in the two cases depends on the weight of water and the height through which it falls or is raised. In all water power development this is true: the power obtainable in any case is proportional to the product of the *weight of water used* and the *height through which it falls* in the pipes

leading to the turbine or other water wheels. Thus 1,000 lbs. of water flowing under a head or height of 100 feet generates the same total amount of power as 100 lbs. of water flowing under a head of 1,000 feet or 10,000 lbs. under 10 feet. In each case the total is 100,000 foot-pounds; it is immaterial whether it flows quickly or slowly, as this simply affects the *rate* at which power is developed and not the *total amount* of power. In any of these cases, if the assumed weight of water passed through the turbines in one minute, the rate at which power would be developed during that minute (or indefinitely, if the flow continued at the same rate) would theoretically be 100,000 foot-pounds per minute, or 3 water h.p., of which about eighty-five per cent. would be available as mechanical power. If this mechanical power on the shaft of the turbine is used to drive an electrical generator instead of a flour mill, then three quarters or more of the original theoretical power in the water will be available as electricity, which in its turn can light houses or drive any machinery, from a fan to a factory, up to distances of over 100 miles.

Where water power is found

In order to get water power on a large scale it is necessary to find:—

(*a*) A small (or, better still, a large) flow of water available with a very high head, which may be anything up to about 5,000 feet, such as may be found in mountainous districts and hill streams at high altitudes.

(*b*) A very large flow of water with a comparatively small head, such as may be found on a canal fall or in a river with a moderate bed-slope or a waterfall. (A combination of a large or moderate flow with a high or moderate head is an ideal combination but is not a distinct case.)

(*c*) As the third possibility, a high head coupled with very large monsoon rainfall and ground capable of storing it in large reservoirs. In this case there may be practically no normal flow; the water stored in the short rainy season is utilized throughout the year, as in the Tata schemes in Bombay.

The slow-moving rivers of the plains of India, with a fall of a few inches or a few feet per mile, are absolutely valueless as sources of water power. Although in *small* streams of this nature undershot waterwheels are often used to drive small mills, the problem becomes impracticable on a large scale, and may be relegated to the category of tidal power and the like. A definite fall (whether a natural fall or one developed by the engineer) is essential; and where the slope of the ground is negligible, and the seasonal rise and fall of the water is great, no practicable fall can be obtained. The common misconception that a natural waterfall is required is, of course, unfounded.

Natural waterfalls

It needs but little imagination to realize the power thundering down a superb waterfall such as Niagara, or the Rjukan Falls in Norway, or the Cauvery Falls in Mysore; all of these are almost in danger of ceasing to be spectacles for the traveller, owing to their water being diverted into pipes for the production of electrical power for industries. No better example of this appeal to wonder could be found than that of the Victoria Falls on the Zambesi, for the development of which for the Rand enormous capital was raised; though the promoters presently found (as anticipated by all but the shareholders) that it paid better to use this capital for a fuel-driven power station on the spot, owing to the great length of transmission involved.

In India at present there are many natural waterfalls adapted for the development of power. Thus, the Cauvery Falls already develop nearly 30,000 h.p., and the Mansan Falls in Burma some 10,000 h.p. Awaiting development are the Hogenkal falls on the Cauvery, capable of producing well over 3,000 h.p.; the Hundrughag Falls on the Subarnarekha River, possibly worth from 30,000 to 50,000 h.p.; the noted falls on the Tons River in Rewah, now under investigation; the more famous falls at Gersoppa between Mysore and Bombay. Hundreds of others, high and low, great and small, are either known or awaiting discovery in out-of-the-way places, especially in Burma.

Rapids converted to low waterfalls

Instead of a sheer fall a river often descends from hilly country in a series of rapids, no one of which may amount to a true

waterfall in the spectacular sense. Individual rapids may drop from 10 to 30 feet in a hundred yards or less, or may continue for miles to drop at some such rate. In these circumstances a low dam can be built across the river and the turbulent water behind becomes, literally, a mill-pond, while an artificial waterfall is formed over the crest of the dam. By utilizing this type of small artificial waterfall a very large proportion of the hydro-electric installations in America are rendered possible. The pipes are taken off through the dam to the turbines in a power house (generally at the side of the dam, but occasionally *inside* a hollow dam) and the whole normal flow of the river is available, with a drop of from five to thirty or fifty feet as a rule. At Notodden in Norway, some 50,000 h.p. is so developed for producing nitrates electrically, the whole of it obtained from the successive development in this manner of a large number of rapids on one river. The Mississippi is also harnessed in this way. The great rivers of India have enormous possibilities of similar development, the investigation of which has as yet hardly begun; but here the amount of water flowing, above the points where irrigation supplies are tapped off, falls to a comparatively low level after the melting of the winter snows and the discharge of the monsoon rains. This is a disadvantage; but nevertheless the power will be available when it is needed, to the tune of many hundred thousand horse-power. The Jhelum power installation at Mohora in Kashmir is the best known example of this nature at present working in the peninsula; while the Mekadatu rapids in the Cauvery have also been investigated.

Canal waterfalls

Spread over the great irrigation canal system of India are scores of low artificial waterfalls where the natural fall of the ground is too steep for the canal without the aid of a weir. The disadvantage of these falls as sources of power is that the flow of water has to be closed down for a time at some period every year. None the less, for many purposes in which continuity is not essential, it will eventually pay to harness these small falls with their large volume of water. Lists of them will be found in the Reports of the Hydro-Electric Survey of India. Already there have been some few developments; on the Bari-Doab Canal near Amritsar; on the Sirhind Canal at Patiala; on the Ranbir Canal at Jammu (Kashmir);

on the upper Bari-Doab Canal at Dhariwal; on the Ganges Canal near Hardwar; and so forth. Further similar developments are being investigated by those who have entered into agreements with Government for the purpose, and the remainder only await the demand for power in their neighbourhood.

Higher artificial waterfalls from dams

Instead of the low dams required for harnessing rapids, or the low falls where the level of a canal is lowered, dams of much greater height are often constructed where it will be useful to impound a large volume of water. These can also be used for the generation of power, with the added advantage that the water not required at certain hours of the day is stored to give a greater flow at other hours of larger demand for power. Here a greater 'head' of water is available, or a larger artificial waterfall is formed, so that less water will suffice to give the same amount of power. No *visible* waterfall occurs as a rule over a high dam, as it would undermine the foundations; the surplus water is either allowed to escape over a rock bye-pass at the side, where the ground admits of this, or it is discharged by under-sluices at the foot of the dam. There are hundreds of power stations in the world employing dams in this way. India so far has not many. The Bhatghar Dam in Bombay has a small power station and is capable of development up to 3,000 h.p., and the same remark applies to many other dams built primarily for storing water for irrigation. The largest irrigation scheme of this nature now in view is the completed project for a 395-foot dam on the River Sutlej at Bhakra, where the lowest recorded flow of water is not far short of 3,000 cubic feet per second; but as this great reservoir will be empty during part of every year it cannot be utilized directly for power purposes. It so happens, however, that the river makes a great loop near here, and that a fall of some 300 feet can be obtained by tunnelling through the intervening hills; in this way some 80,000 h.p. would be available all the year round, without interfering in any way with the adjoining irrigation works. This great scheme is now being investigated in detail and will be reported upon before many months have passed.

Very high artificial falls on hill streams

There is even yet another method of obtaining water power, namely, from smaller streams descending steeply from a high altitude.

Here there need be no dam at all, and if there is one it is built only to facilitate the drawing-off of the water from the stream. The method employed for obtaining an artificial fall here is to carry the water along the hillside, sometimes in pipes but more often in an open channel or canal. In this way the stream rapidly drops below the level of the comparatively level canal (or closed conduit); and in the end, after a mile or two, the water will be brought to a tank or 'forebay,' perhaps 500 or 1,000, or even several thousand feet, above the stream. From this tank high pressure pipes are taken down to the Pelton wheels which drive the generators before the water returns to the stream. Here, if, for example, the head or fall is 2,000 feet, one-hundredth part of the water required at a twenty-foot dam will give the same power. On the other hand, unless the natural lie of the ground is very favourable. the capital cost of the works may be much higher. The very long and strong steel pipes, required to drop this great distance and to withstand this great pressure, are themselves one of the main items of expense. Naturally they will not be vertical, as they must follow the slope of the ground; so that a fall of 2,000 feet may involve a pipe from 4,000 to 6,000 feet long. Examples of this class of high-fall development are found in every mountainous country, the vertical head of water amounting in one case to over a mile and in many cases to several thousand feet. In India the hill stations of Simla, Mussoorie and Darjeeling are all served with power from this type of scheme, the last-named being the pioneer hydro-electric station of India (1897-98). There are certainly *hundreds* of other sites where similar works could be constructed, but most of them remain to be investigated even when they have been located. Amongst those now being examined in detail one of the most promising is on the Jaldaka River in the Bengal Duars, on the borders of Bhutan, for the use of which an agreement has already been entered into; another is the Kundah River scheme in the Nilgiri Hills, which Messrs. Tata are developing.

Storage reservoir works

I have already explained that in addition to hydro-electric schemes depending on the flow of a river or stream there are also others which depend primarily on monsoon storage. India has the distinction of having been the first country in the world to develop

this class of scheme, namely in the Western Ghâts. The rainfall on the crest of this range of mountains during its short season is extremely high, *viz.*, from 150 up to more than 250 inches; while during the rest of the year there is practically no precipitation at all. Much of this rainfall is carried right away to the plains, where it is used to irrigate the Deccan and more distant areas, but as its descent cannot be stayed the greater part flows to the sea. It was long ago realized that by storing some of it the irrigation season could be greatly lengthened, and a comprehensive survey of the many reservoir sites in the Ghâts was undertaken by Mr. Beale of the Bombay Irrigation Branch. Great dams were built, from which the irrigation canals take their supply long after the monsoon has ceased. The credit of seeing that similar reservoirs in this area could be used for power production is due to a civil engineer, Mr. Gostling, who induced Messrs. Tata and Co. to develop their first great undertaking at Lonaola. Here reservoirs at a high altitude, impounding many thousands of millions of cubic feet of water, store the whole monsoon rainfall. This is brought as required, throughout the whole year, to a power house nearly 1,800 feet lower down, where electricity is generated for transmission to the Bombay cotton mills. Two other similar schemes in the same neighbourhood, those of the Andhra Valley and of the Nila-Mula, will shortly add their quota of power, and between the three some 200,000 h.p. of plant will be installed. The Koyna Valley storage project further south is capable of being developed to give no less than 300,000 h.p. continuously, if a demand should arise for so great an amount, and would store no less than 120,000 million cubic feet of water.

Crossing watersheds

It often happens that, while the water can best be collected (and perhaps stored) on one side of a watershed, the fall of the ground on that side is too gradual for economic development, while on the opposite side the fall is steep. In these circumstances a tunnel is often carried right through the watershed, and the pipes to the power house are carried down on the reverse side to the catchment area. This is so in the case of the Andhra Valley works, where the overflow from the great artificial lake drains eventually into the Bay of Bengal through the Kistna River, while the water used for

power purposes flows into the Indian Ocean some 600 miles away. More often, however, it is only a local, and not a main, watershed that is crossed in this manner; more frequently still, as illustrated by the Sutlej scheme explained above, a tunnel is used merely to shorten the distance round a bend in a river by piercing the intervening spur.

Origin of the Hydro-Electric Survey of India

In 1918 the Government of India decided to act on the suggestion put forward by the Indian Industrial Commission that a survey should be made of the water-power resources of India; and, as the subject was a novel one in the country, two engineers were appointed with instructions to look into the question and to make recommendations as to how the work should be carried out. Up to that time practically no information had been collected in this country. It is true that a request for information as to probable sources of water power had been addressed to local Governments by the Government of India many years before, but owing to a lack of technical knowledge of the subject the results were sometimes misleading and generally inadequate.

The Preliminary Report of the Survey

At the end of the season 1918-19 a considerable amount of information, hearsay and intelligent guess-work, had been collected, and a preliminary report was published in 1919 setting forth such details of all probable or known sites as had then come to hand. The report, however, went further than this; several chapters and appendices were devoted to an elementary exposition of the subject of water power in all its bearings, and suggestions were made as to the method of carrying out the survey and the policy recommended for dealing with power actually proved.

The Second Report

By the beginning of the second working season the general lines on which the survey should proceed had been laid down; namely, that it should be carried out in each province under the orders of the local Government, but that the two officers in charge of the whole survey should co-ordinate the work. In Bombay, Madras, the United Provinces, Bihar and Orissa, Assam and Burma.

officers at once took up their duties and the survey is proceeding. At a later date the Administration of the Central Provinces appointed an officer, but after a year his services were required for famine works. In the Punjab a special Public Works Division was formed to investigate the Sutlej River project, but the great potential resources elsewhere in the Province have so far not been examined. Bengal has been unable to spare an officer as yet, so that nothing has been done there. A certain amount of reconnaissance work has been carried out also in Indian States; but the immense resources of the territories adjoining British India along the Himalayas are outside the scope of the survey. The results of the second season's working are recorded in the Second Report.

Results up to date

To ensure as much publicity as possible, copies of both reports have been distributed to all persons known to be interested, as well as to the Press, and extracts from them have consequently appeared in the technical papers all over the world. One gratifying result is that at the present time expert representatives of most of the leading firms of British manufacturers of this class of plant are touring the country and seeing for themselves what the prospects are. This was the more necessary as hitherto such plant has been mainly supplied from America or the Continent. Another promising sign is that a number of applications have been made for the right to develop particular sites that have been proved good; and several definite agreements have been entered into between promoters and the Government.

Reconnaissance work

The first stage in the preparation of any hydro-electric scheme is the reconnaissance of the site. We may assume that information has been received from some local source that the possibility exists of developing some river or stream; or perhaps an examination of the modern one-inch to the mile contoured maps (which, unfortunately, only exist for a very small part of India) shows that the ground may be favourable for such a development. Then a reconnaissance is made to examine the ground, preferably at the driest time of the year, and rough determinations are made by aneroid or Abney level of the fall available at various points.

The nature of the river bed and banks is examined in case a dam should be advisable. The examination shows which type or types of development will be possible and which is likely to prove best in the circumstances. The discharge of the river or stream is roughly estimated, in order that data relating to it which may have been previously collected by the Irrigation Branch may be used to the best advantage. If no details of the flow at different seasons are on record, arrangements are made for gauging the stream over a longer period, or an automatic water stage recorder may be erected. Local enquiries from intelligent persons, especially those owning small water mills, may be of great value. If the stream offers any possibility of storage this is duly noted. The lie of the ground for open channels and pipes is examined on both banks, and possible sites for a power house are located. In the office, the engineers determine from the maps the catchment area over which rainfall is collected to supply the stream at the point chosen; the rainfall records within or near this catchment are examined over a series of years; and such estimate as can be made of the probable flow at different seasons is forecasted. This briefly describes the preliminary work which is recorded on printed forms. It will be seen that it takes time, and that one officer, in a season of 6 months or less, cannot cover a province.

Survey of sites

Where the result of the preliminary reconnaissance shows that the site can be developed for a reasonable amount of power a more detailed survey is undertaken: the intake point where the water can be tapped off from the river or stream to the best advantage is pegged out, as it is also the most favourable site for the power station. From the latter the pipe line is then pegged out, except in those cases of low-fall development where intake and power station are all at one point. The highest point of the pipe line may be at the stream intake in favourable cases; or a channel on a very small slope, of greater or less length, may be required to unite the two. At the top of the pipe line a forebay is pegged out, where the supply of water to the pipes will be regulated and controlled. If there is a reservoir in the scheme it is also pegged out. Then a plan of the ground is made and precise levelling determines the altitudes (or relative altitudes) of the fundamental points. At these bench marks are made. Then the headworks,

at the intake are designed; the dimensions and slope of the channel (if any) are calculated; the point where the forebay will be built is more exactly surveyed, now that the termination of the channel locates its level, and it is designed; the exact vertical fall from the forebay to the turbine shaft and the tail race, where the used water will be discharged, is found from the bench marks; the direction of the pipe line, its length, and its horizontal or vertical bends, are measured and drawn, and the power house is laid out.

Limits of Government survey

It is not the intention of the Hydro-Electric Survey at present to design complete hydro-electric schemes, which involve not only the hydraulic development and power station but also the design and location of transmission lines and (most important of all) the examination of the questions involved in the use of the power when it is available. A single scheme worked out in detail would take a staff of engineers and draughtsmen many months. The present intention is to ascertain—

(1) where water power can be developed·
(2) how much power can be developed:
(3) on what lines the development should proceed in any case:
(4) whether a particular development will be (comparatively speaking) a cheap one, a moderately expensive one, or a very expensive and, perhaps, prohibitive one.

Cost of Hydro-electric schemes

This last consideration brings us to the economic aspect of water power: and here hydro-electric stations must be in a position to compete with fuel-driven plants. The comparison will, in the first instance, be on the basis of the cost in rupees or pounds sterling per horse-power of working plant installed. It will be obvious that in all cases large capital expenditure is necessary on hydraulic development. Furthermore, as water power must be developed where it is found, a long transmission line is often necessary. For these reasons the total cost of construction is almost invariably higher than that of a steam-driven plant of the same capacity; and the annual capital charges for interest and depreciation are correspondingly higher.

Against this may be set the fact that the running costs of such a station are relatively low, as no fuel is involved. The total cost of running does not depend to any appreciable extent on whether the plant is fully or only lightly loaded; it is practically a fixed sum per annum made up of capital charges and the wages of the persons employed; so that the cost per unit of electricity is practically proportional to the total number of units generated. This is not so with fuel-consuming stations. Every extra unit generated by them involves the consumption of a definite amount of fuel with a definite cost; and, while the total cost rises with the number of units generated and the cost per unit falls somewhat, the latter is by no means proportional to the total units. In any particular case. therefore, the practicability of a hydro-electric scheme depends to a great extent on the cost of fuel in the locality where the power is wanted.

To take an example. Assume a plant of 5,000 horse-power capacity is required at a certain place where sufficient water power exists within transmission distance. Assume the total cost of the hydro-electric scheme and transmission line to be Rs. 50,00,000. (It might be very much less in favourable circumstances.) Taking interest and depreciation together at 10 per cent. the annual cost on this account will be Rs. 5,00,000.

Let the cost of a steam plant of the same capacity, built *where the power is actually needed*, and therefore without any long transmission line, be assumed to be Rs. 15,00,000 with similar annual capital charges of Rs. 1,50,000. Now, if for simplicity it be assumed that the annual charges for wages, stores, repairs and supervision are the same in both cases (an assumption near enough to the truth) there will be the difference between Rs. 5,00,000 and Rs. 1,50,000, or Rs. 3,50,000, to set off against the cost of fuel for steam raising. Under the ideal conditions of large electro-chemical works, this plant, allowing 1,000 horse-power to be kept in reserve, and, therefore, 4,000 for work, would generate about 28 million units (80 per cent. load factor). Under ordinary industrial conditions the output would be less than half this, or, say, about 12 million units. Clearly, therefore, not only the cost of coal but also the load factor of the plant (*i.e.*, in non-technical language the ratio of its *actual* to its *possible* output) is of immense importance. If it is assumed that the low amount of only 2 lb. of Indian coal will be required

per unit, with modern plant of large size, the consumption would be 25,000 tons for 28 millions of units and 10,700 tons for 12 million units. As the amount available to make the costs just balance out between steam and water power is Rs. 3,50,000, it follows that, with the larger output, coal at Rs. 14 per ton would absorb this amount, while with the smaller output the figure would be nearly Rs. 33. Generally, the coal consumption would be nearer 4 lb. per unit, in which case the Rs. 3,50,000 would be absorbed with coal at Rs. 7 per ton for 28 million units and Rs. 16½ per ton for 12 millions, thus increasing the advantage of hydro-electric power. From this example (in which the figures are not meant to represent estimates) it will be inferred that as the load factor rises towards the ideal limit the advantage of hydro-electric power increases. Bearing in mind the vast difference in the cost of fuel in different parts of India, due mainly to railway freight, it will also be seen that the distance from fuel supplies is a very material factor. With coal under Rs. 10 per ton it is doubtful whether water power could ever compete unless (a rare combination) it existed right on the spot and could be developed exceptionally cheaply. On the other hand, with fuel at over Rs. 30 a ton, water power would generally prove cheaper, and for a well-sustained industrial load invariably. Between these limits proper estimating would be necessary.

The fallacy of the 'lowest tender'

An interesting side light on the above discussion is also worthy of mention. The inexperienced financier is notoriously apt to look at present capital expenditure and neglect to take into consideration future recurring cost; consequently he often accepts the lowest tender to his ultimate detriment. We have first assumed above that a steam plant of 5,000 horse-power total capacity cost Rs. 15,00,000, and requires 2 lbs. of coal per unit. Now, on the two total outputs assumed, the consumption of coal on this basis is 25,000 and 10,700 tons. Would it pay to accept a tender of Rs. 12,00,000 for cheaper plant of the same output if the fuel consumption were then 2½ instead of 2 lb.? The extra fuel used would amount to 6,250 and 2,675 tons in the two cases. Taking 10 per cent. on the capital cost saved by accepting the lower tender, the annual saving is Rs. 30,000; the extra fuel used, even at Rs. 10 per ton, comes to about Rs. 62,000 with the large output of units

and to about Rs. 27,000 with the lower output. Thus, with very cheap fuel and a 'bad load' it sometimes pays to buy comparatively uneconomical plant; but with expensive fuel and a good load factor *never*. If the cost of fuel assumed were Rs. 15 instead of Rs. 10, the more expensive plant would prove the cheapest on either the large or the small load. Much money has been wasted in India and much disappointment caused by the neglect of these principles.

The industrial uses of electricity

Hitherto electricity has been mainly associated in the public mind with lighting and fans. These are excellent in their way, and have been little developed in the last 20 years. In the industrial life of a country, however, they can play but a small part, subsidiary to manufacturing industries. Slowly but surely the driving of mills and factories by electricity is coming into play, and a great extension of electric driving is yet possible. But it is in the use of electricity directly, in the furnace, the arc or the electrolytic cell, that the real future lies. The most important processes are, perhaps, those for the fixation of atmospheric nitrogen into the nitrates of commerce. Norway was the first country to develop this industry on commercial lines, and recently, when nitrates were scarce and freights heavy, and the peaceful demands of agriculture had been superseded by those of war, other countries hastily began making up leeway. The production of aluminium from alumina, of which bauxite is the most generally used raw material, is, perhaps, next in importance to the nitrates. The steel industry, again, is being slowly revolutionized by the electric furnace, which introduces economies in the utilization of what has hitherto been regarded as 'scrap' and turns out a finished product superior to that of other and older methods The various ferro-alloys, used for high speed tool steels, armour plate, projectiles and the like are nearly all products of the electric furnace. Pig-iron itself, the basis of the whole steel industry, is being smelted from its ore in the electric furnace with a saving of much valuable fuel and a purer product; the latter because less ash and sulphur and phosphorus are present in it. Amongst other processes of importance are the electrolytic production of carbide of calcium, used primarily for the acetylene industry, for lighting and metal cutting with the oxy-acetylene jet; secondarily, for the production of cyanamide-

(a valuable fertilizer) from which both ammonia and nitric acid can in turn be manufactured. Yet again, industrial chlorine, oxygen and hydrogen are largely produced electrolytically; also various chlorates and hypochlorites, of value for explosives and bleaching respectively; phosphorus is distilled from its compounds by the arc process; carborundum and other abrasives and artificial gems are made; the whole of the copper used in the electrical industry is refined by depositing it from impure commercial metal; and sodium and allied metals with a great affinity for water are produced.

'Power factor' and cheap units for industrial power

In most water-power plants hitherto developed the capital cost has been high, and the sale price per unit correspondingly so. The technical discussion above has, it is hoped, made it evident that, as the total annual cost is practically a fixed sum, the unit can be sold far cheaper to a consumer who is using all his machinery, etc. throughout the twenty-four hours than to one who only uses it for two hours: in fact, in the ratio of about 12 to 1. This is the reason why consumers always have to pay higher rates for domestic lighting than for industrial power; it is true whatever the source of power may be, but more so with water power than with steam. The usual selling rates for lighting in India are from 3 to 6 annas a unit; for industrial power, from 1 to 2 annas where steam is used and somewhat less where the plant is water-operated. Here, again, an interesting contrast may be drawn between steam and water. No matter how ideal the conditions may be, every unit sold from a steam station costs a definite sum in fuel; and therefore, even though some of the plant may be idle, there is an absolute limit below which sales would result in loss. Paradoxical though it may seem in view of all other commercial transactions, there is practically no such limit in the case of a hydro-electric station, except when it reaches the full possible limits of its development, and not always even then. The total working costs are not affected by the generation and sale of additional units. Therefore, when all the load has been obtained that is in sight at normal tariff rate—for dividends must be obtained—extra sales *at any price* will pay so long as they do not involve an increase in the size of the plant. They bring in money without involving any expenditure.

This will be more evident if an example, simplified in order to avoid diagrams, is given. Suppose a hydro-electric plant with a working capacity of 4,000 horse-power actually had this load (or thereabouts) during the whole working day from 6 A.M. till 6 P.M., but that for the remaining twelve hours its mean load was only 1,000 horse-power, the average generating cost of a unit being 0·5 anna under these conditions. If there were no prospect of obtaining work for the idle plant during these night hours on the ordinary tariffs, it would pay to take on consumers at 0·3 or 0·2 or even 0·1 anna per unit *provided* they were restricted to the use of power at night only. Their additional consumption would mean many more units generated, but the total cost of running the undertaking would be unaltered, so the *average prime cost* of a unit would be reduced. Apart from this, however, the total revenue would be definitely increased by the whole amount realized from these sales under cost price. If, for instance, night-working factories were started using the whole available 3,000 kilowatts, the average cost would be reduced from 0·5 to about 0·3 anna. But, as stated, in order to get this extra revenue it would pay to supply this factory at a far lower figure than the reduced average. It is, in fact, constantly done in actual commercial undertakings. The undertaking would in this example obviously make an additional profit of 0·2 anna on every unit sold to the original consumers, so that it would gain in two directions.

Conditions required for economical industrial development

Where electro-chemical industries on a large scale are in question, it is essential that the price of the power shall be very low if the manufactured product is to compete with that produced elsewhere. The cost of power is, of course, only one item amongst many in determining the sale price of the finished article, but it is a very important item; perhaps, in these industries second only to the freight of the raw material to site and of the finished product to market. Where the conditions of the hydraulic development are such that construction on a large scale is reasonably cheap; where the locality is such that the freight of the plant and materials thereto is low; and where the length of transmission to the factory is reasonable, power can probably be delivered at about one-tenth of an anna per unit, including all charges. Indeed, if the cost is much

higher than this the proposition becomes untenable. Obviously, the undertaking must be on a fairly large scale to be of any use. The larger the individual units of plant are made the smaller becomes their prime cost per kilowatt and the higher their efficiency. It must not be forgotten that at the present day there are *single generating sets* (steam turbine or water turbine and electric generator) of 30,000 and even 50,000 horse-power capacity, while the whole of the Tata Hydro-Electric company's scheme only amounts to about 70,000 horse-power. The various electro-chemical industries are favourable to these low costs, as they are practically continuous processes, utilizing the whole plant to almost its utmost capacity throughout the year.

Freight

In considering the value of sites that may possibly meet these ideal conditions the first point to consider is undoubtedly that of freight and carriage, for it has a triple application. In the first place, the raw material must be brought to the site, unless already on it. Secondly, the finished product must be taken to its market. Thirdly, the plant must be delivered at the power house. Cases are known where the carriage of plant over 20 miles of mountain roads cost more than its freight from England to the railway terminus; and cheap power is useless if the saving is swallowed up in expensive freight. Where bulky raw material has to be brought to the factory and sent back finished the obvious course is to build an electric railway from the nearest terminus, seeing that cheap power for working will be available. In order to get the plant to the power house there must be a road, and this road should be built so as to afford a suitable track for the subsequent railway. During the construction period a light line worked by steam will probably pay as against other methods of transport of the plant. The tendency of the man who puts his travelling crane up after erecting his plant is often only too apparent in these matters, and carriage by coolie is seldom cheap.

Transmission of power

From small beginnings electrical transmission of power has now reached the stage where it is possible to have the factory 250 miles or more from the power station, and it would be unwise to say that the limit of high pressure has been reached. A new system is, in fact, being discussed at the present time by which it *may* be possible

(if practice confirms theory) to transmit up to 1,000 miles with no more loss than at present. In the case of water power from mountainous country there may be insuperable difficulties of ground or cost in laying out a railway to the site, though the plant can be transported there. Even if these difficulties do not exist, if the raw material of the industry is within the limits of transmission, it will probably prove cheaper to erect a long transmission line rather than a railway, which may also use more power than will be lost in transmission. It is simply a question of estimating which method gives the cheapest finished product. Either the material can be brought to the power house, or the power to the factory, or a combination of both methods may be the best. Mountainous country has one great asset for transmission, in that the ridges form nature's own supports for the lines: with comparatively small towers the valleys offer plenty of room for the dip of the wires on long spans. It also follows that by the use of long spans and reducing the number of points of support there are fewer points at which damage from lightning can occur. The loss in transmission can be made almost as large or as small as the designer chooses, according to the size of the wires used; ordinarily about 10 per cent. is allowed. With unlimited water power the cost of the lost power is of secondary importance, and larger losses may be advisable than in the former case. On the other hand, if all the available power is likely to be required, and this is generally the case, the line losses may have to be reduced to very low amounts, since every unit available for the factory is of value. In any case, however,—and this point is often overlooked—every additional mile of transmission line not only loses some power but also adds a matter of Rs. 10,000 or so to the capital cost. The interest and depreciation and maintenance charges on this add directly to the cost of the power delivered at the far end of the line. Thus, the actual cost of a unit delivered at the distant factory may be two or three times what it is to another factory close to the power house.

Cheap development

In large steam-driven plants the capital cost of the power house and plant is a matter which can be forecasted with accuracy, except for the cost of freight and carriage, independently of where the site may happen to be. This cost will vary within comparatively

small limits, especially according to whether there is a satisfactory water supply for the boilers and for condensation; and this latter point will affect the running cost greatly. On the other hand, the capital cost of a hydro-electric scheme may vary enormously in different cases. In the class of undertaking having a large head of water with a small flow, the water has generally to be carried along an open flume for miles in order to reach a point at which the largest available drop can be utilized by means of the shortest length of steel pipes. Then a certain amount of storage at this pipe head is essential, in order to guard against the failure of the supply through a break in the flume. Then, again, the steel pipes themselves may be longer or shorter according to the ground. Landslips and bad ground have to be guarded against, tunnels constructed, and other streams bridged. These various conditions involve enormous variations in capital cost, which can only be forecasted by surveys and estimates.

The class of undertaking with low or moderate falls and a large volume of water includes both canal and river developments. Canal falls are for the most part very low, and though the power house and foundations will generally be expensive, the rest of the development does not vary greatly in cost. Annual closures, however, militate largely against the use of these falls for industrial purposes other than sub-soil pumping or high level irrigation. River developments, except that they usually do not require storage reservoirs, may vary indefinitely in cost. Difficult problems are involved in drawing off the water at the head works and in conveying it to the power station, and the limits of cost may vary almost as much as in the case first considered. Floods and the great variation in the height of the head and tail waters offer further difficult problems.

In the remaining class of undertaking large storage is the crux of the problem. No matter what the monsoon rainfall may be, unless sound natural reservoir sites exist development is impossible. If dams can be built to impound enough water to run the station throughout the year, and if the capital cost does not prove so great that steam would be cheaper, well and good. Here the height of the reservoirs above the power station must be as large as possible, for *every extra foot means extra power*. On any given head every ton of water behind the dam represents a certain definite quantity

of power in horse-power hours (or in units) *and in money*, and as the quantity of water is limited, every extra foot in height means additional revenue. Thus, every hundred rupees spent on masonry may provide an amount of power varying both according to the altitude of the dam above the power house and the number of cubic feet of water it stores, depending on the configuration of the ground.

Conclusion

This general 'survey of the Survey' will, it is hoped, stimulate public interest in the problems involved. All these problems require expert investigation. The first stage in such an investigation is to decide what industries are to be undertaken, where the raw materials of the same are to be found, and the power required for them. This lies within the province of the Director of Industries and of those whose work marches side by side with that of the Director. It concerns even more closely the capitalist who will find the money for the factories; and the experience of other countries proves this form of enterprise to be a sound investment. Simultaneously the Hydro-Electric Survey will ascertain the sites where sufficient power is available and capable of development at a reasonable cost. It may here again be urged that, as the extra large capital involved is merely a set-off against fuel, the rent charged for the use of the water in a canal or river should be absolutely nominal; for passing it through turbines does not prevent its subsequent utilization for irrigation, and it is nature's gift of gravity and *not* water *quâ* water which gives the power. Rivers of quicksilver would give thirteen times as much power in the same circumstances. Having found conditions suitable for starting an industry and water power to work it, the practicability of bringing the raw materials and power together must be examined, together with questions of freight and carriage. Finally, it must be determined whether coal utilized at the pit's mouth can or cannot compete with water power; and in this connection existing railway facilities evidently play a considerable part. There is work here, not only for the electrical engineer, but also for the chemist, the geologist, the meteorologist, the irrigation engineer and the water-power expert. It is work that will take time and cost money; but in the end it will help to bring prosperity to the millions of India in a way that no cult of the hand-loom is ever likely to do.

J. W. MEARES.

FACTORY CHILDREN AND EDUCATION

BY

A. G. CLOW, I.C.S.,

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A suggestion was actually made to an Indian Factory Commission that education should be discouraged because it would spoil the children for the purpose of factory work. But those who are opposed to the education of factory children, or any other children for that matter, need hardly be taken seriously. They have always been few, and, if they have not gained any hearty love for education in general, the course of events in the last few years in Russia and elsewhere has probably convinced them of the dangers of a large and uneducated industrial population.

The great majority, who wish to advance the education of factory children, have followed two main lines of thought. Some have concentrated on the education of half-timers, *i.e.*, children actually working; others have aimed at securing some education for the child before he enters the factory.

Until 1881 there was no limit to the hours a child could work in a factory. From 1881 to 1891 the limit was 8 hours; from 1891 to 1911 it was 7 hours; in 1911 a reduction of one hour was made in the case of textile factories, and a similar reduction is now proposed in non-textile factories. Even a six hours day, when allowance is made for journeys to and from the factory, does not leave much margin for education, and it makes it essential that, if education is given, it should be provided on or near the factory premises. It is only natural, therefore, that those who have been protagonists of the idea of the education of half-timers should have advocated the provision of this education by the employer. This idea has a long history, and actually owes its birth to the liberality of a few employers.

When the first Factory Commission was appointed by the Bombay Government in 1875 two mills, the Bombay United Spinning and Weaving Mill and the Morarji Goculdas Spinning and Weaving Mill, maintained schools for the children they employed.

The managers of these mills, who were examined by the Commission, compelled the children to attend the schools, and they were both in favour of compulsion being brought to bear upon other managers to do the same. In both cases the institution of the schools appears to have been due purely to the desire to advance the cause of education, and it is not difficult to picture the surprise of one manager when a member of the Commission asked him if he deducted anything from the wages of the children for attending school. Again, in 1890, Dr. Lethbridge's Commission, which advocated a considerable reduction in the hours for children, considered it "most important to provide some means of instruction during two or three of the spare hours that the children are off work." They suggested that local Governments should co-operate with employers and that each should provide half the cost of the schools.

Both in Bombay and in Bengal the idea of educating the factory children was taken up by an increasing number of employers, and in 1893 the Bengal Government, reviewing the administration of the Factories Act, noted that in several mills the children attended school twice a day for 2 hours at a time. They added: "This enables them to attend the mill throughout the day. The plan is one which deserves to be generally adopted." At the same time, the Chief Inspector of Factories in Bombay commented unfavourably on the education given in the mill schools there, and remarked that the managers looked on the schools as a convenient means of keeping the children together in their spare hours. It is curious to note that each of these conflicting views was endorsed by investigating bodies in 1907-8. In 1907, Sir Hamilton Freer-Smith's Committee "noticed with great satisfaction" schools on the premises of certain mills, and they considered that the question of providing similar facilities for education at the expense of the employers in all mills might be taken up by Government. The Indian Factory Labour Commission in the following year came to a contrary conclusion. In paragraph 18 of their report they gave reasons for believing that the schools were, in most cases, thoroughly inefficient, that the teachers were quite incompetent and that in many cases the children had received no education at all. While they admitted that, in the first instance, some mill-owners had introduced schools with the best of motives, they were forced to the conclusion that, in a large number of cases, the only object was to keep the

children within the precincts of the mills during the whole of the day. They were in consequence strongly opposed to schools in the precincts of mills, and they were also against laying the burden of education on the mill-owners, though they apparently hoped that employers would contribute to state-managed schools.

It was in consequence of the recommendations of this Commission that the Bill which finally became the Indian Factories Act of 1911 was introduced. In the course of the debate the Hon'ble Mr. Gokhale moved the insertion of the following clauses: –

(1) Every factory, in which more than 20 children between the ages of 9 and 12 are employed, shall maintain an elementary school in proper condition for their benefit, and attendance at such school for not less than 3 hours every working day shall be compulsory in the case of each child so employed

(2) No fees shall be charged for the instruction given in such school.

Mr. Gokhale put forward three reasons for the adoption of his proposal:—

(1) That factory work prevented children from making use of the ordinary facilities for education.

(2) That the shift system compelled the children to spend several idle hours in and about the mills, and that this period would be better spent in school.

(3) That the parents also work in the factories, and so could not supervise their children.

The Legislative Council was not prepared to support Mr. Gokhale's proposal and he eventually withdrew it, remarking that he did not expect that Government would do more than urge on the local Governments the necessity of looking into the matter. A somewhat similar proposal was considered in Bombay in 1913 when a Committee recommended that the 6 hours of work permissible to half-timers should be divided compulsorily into 3-hour shifts with a considerable interval between. The interval was to be utilized for the instruction of the children, and the intention apparently was that this instruction should be compulsory. In 1914 the Bombay Government published a draft rule under section 37 of the Factories Act embodying their proposal. This was criticized by employers as unwise and by lawyers as illegal, and the Bombay

Government then proposed an amendment of the Factories Act to achieve the same end. The question was under the consideration of the Government of India and other local Governments when further discussion was suspended owing to the war. But the Industrial Commission of 1918 criticized the proposal as illogical, and in the present Factories Bill no such suggestion has been embodied.

When the Bombay Primary Education Bill was before the Bombay Council in 1917 the Hon'ble Mr. Chunilal V. Mehta suggested an amendment by which the cost of providing education for children employed in factories should fall upon the owners of factories. But the view that it is the duty of employers to educate the children has steadily lost ground. This is partly due to the increasing recognition of the duty of the State in this matter and partly to the increasing minimum age for children. While there was no limitation on the lower age of children, and later, when the lower limit was very low, the case was strong. If children of 7 or even 9 are to be employed, their education, however elementary it is, must overlap on their working years. If, as is now proposed, the lower age is raised to 12, this will leave room for education up to the primary standard before a child enters the factory. At the same time it would be ungenerous to pass over the endeavours which many employers have made to tackle the question on their own account. But it is worth noting that employers' schools have been most successful where they have contained a large percentage of children who are not actually working, *e.g.*, children of employés and others. Good examples of this are the Buckingham and Carnatic Mills School, Madras, which is run on the voluntary principle, and the East Indian Railway's colliery school near Giridih, where compulsion is applied and over 2,000 children attend. It may be questioned whether a child who is doing six hours work in a factory is capable of assimilating much education given him in the spare hours of his day, unless the foundations have been laid before he enters the factory. What is wanted is education before employment, whether it is continued during employment or not.

Those who wish to secure for the child a certain minimum standard of education before he enters a factory have naturally concentrated upon the minimum age for admission. But even in this there have been marked differences of opinion, more especially between those who wish the minimum age to be a fixed one and those

who favour the idea of making the minimum age vary with the education of the child.

What may be called the 'premium on education' idea started, as far as India is concerned, with a second Bombay Commission which was presided over by Mr. W. B. Mulock, I.C.S., and examined the question of factory legislation in 1884. They recommended that the minimum age of children should be raised from 7 to 9 and that the maximum age should be raised from 12 to 14, but that a reduction of one year should be made, both in the maximum and minimum ages, in the case of children who had passed prescribed educational tests. This proposal did not receive the approval of the Bombay Government who remarked that "attendance at school may educate the mind but it does not necessarily educate the body," and stated their opinion that the suitability of a child for employment in a factory should be determined by a reference to his physique and not to his education. This argument, so far as it goes, is perfectly sound, but it is far from a complete answer to the proposal, for it is perfectly possible to introduce a physical test for admission into factories—as was done in India by the Act of 1911—and to provide at the same time for a premium on education. The result of this would be, not the inclusion of certain children who are physically unfit because they happen to be better educated, but the exclusion for a short period of children who might be physically fit but who had not obtained a certain minimum standard of education.

A somewhat analogous proposal recurred in the report of the Factory Labour Commission of 1908. They wrote:—

> "Further, in order to encourage the education of factory children we propose that any child of 13 years of age, who can produce a certificate showing that he has passed such educational standard as each local Government may fix from time to time, should be permitted to work as a 'young person,' if certified as physically fit to work 12 hours a day." (Report, para. 91.)

This proposal was based on the English Factories and Workshops Act of 1901. By section 71 of that Act a child in possession of a certain educational certificate could be employed as a young person a year earlier than would be possible if he had no such certificate.* The proposal of the Indian Factories Commission was

* The Employment of Women, Young Persons and Children Act, 1920, apparently makes this provision inoperative. A. G. C.

dropped when the idea of a young persons class was abandoned. As it related to the maximum and not the minimum age of children, it would, if successful, have encouraged the education of half-timers rather than the education of children before employment. At the same time the Commission admitted that half-timers were usually too tired to receive much education, and they noted that the English provision had not had much effect.

The sounder idea of putting a premium on education as regards the minimum age received influential approval in 1919, when the International Labour Conference adopted a proposal that, while the minimum age of admission for children to factories in Japan should be 14, children of 12 might be admitted if they had finished an elementary school course. This school of thought, at any rate, is still very much alive

An interesting and novel combination of the two ideas of putting an age-premium on education and compelling the employer to provide the education is exemplified by the factory regulations of Baroda State. These provide that children of 9 years of age and over may be employed in factories, provided that the management makes satisfactory arrangements for their education. If such arrangements are not made, no child under 12 can be employed. In consequence, schools are maintained in all the mills. The scheme cannot, therefore, be criticized as unsuccessful, but such a provision will not satisfy those who believe that, if the elementary education of a child is to have a fair chance, the child should not be allowed to work in a factory at the same time.

It is this latter view that is steadily gaining ground. The fund of energy possessed by a man or a child is limited, and prolonged muscular exertion renders a person less capable of mental activity. While it may be possible for a child who has received some education to continue that education in classes conducted during his spare hours for one or two hours a day, it is unlikely that he will make much progress if he has not had a good grounding before he enters the factory. And with a minimum age of 9 it is only a very precocious boy that can learn much before he enters. Consequently, efforts have lately been concentrated upon the extension of facilities for primary education and on the raising of the minimum age for factory children.

Here again there is a sharp division of opinion. Some believe that the first essential is the raising of the minimum age: others think that the minimum age should depend upon the facilities for

primary education. Those who support the latter view tend to dwell upon the pitiable case of children driven out of the pleasant mills into the inhospitable streets. When this view is put forward by an employer, there is a temptation to regard his advocacy as inspired by the fear of losing profitable hands if the age limit is raised. But in theory, the view that, if there are no educational facilities for a child, it is better that he should do light work than remain idle, appears very sound. And it received a certain amount of qualified support from the Indian Industrial Commission of 1918. They came to the conclusion that the first step should be "to introduce compulsory education in areas where this is feasible, applicable to all classes of children and not merely to those employed in factories." And they added: "any consequential amendment of the Factories Act may then be considered." These views, divorced from their context as they are above, have been used as an argument against raising the minimum age for children. But it is important to notice that they were advanced in opposition to an idea, then prevailing, that devices such as splitting the shifts for half-timers would give substantial encouragement to education. On the independent question of the proper minimum age for employment the Commission expressed no opinion.

In practice, the postponement of a rise in the minimum age of children until adequate facilities for primary education had been provided would produce effects very different from those desired by its advocates. It would not merely result in the postponement of a reform that is now recognized as essential—the raising of the minimum age. It would also result in a setback to the cause of education. For suppose that a low minimum age were retained, and a statute passed by which this age would rise if and when provision for compulsory primary education had been made. Then the introduction of compulsory primary education in any area would involve the exclusion of children who would otherwise be permitted to work in factories. The inevitable result would be that those who were opposed to the educational reform on financial grounds—and they would always be numerous—would be reinforced in their opposition by those who find the labour of the child profitable, *i.e.*, by the parents and the employers. Thus the effect of a provision designed to encourage education will be the strengthening of the opposition to the spread of education. On the other hand, if the age of children is raised before facilities have been provided for their

education, neither the employers nor the parents will raise the same objection to the introduction of a compulsory education scheme.

The history of the Compulsory Primary Education Acts furnishes an interesting commentary on this. The Hon'ble Mr. Gokhale introduced an Elementary Education Bill in the Imperial Legislative Council, but it was rejected in March 1912. It formed, however, a basis for the subsequent provincial Acts. The first Bill which actually passed into law was for Bombay outside Bombay City, and was introduced by Mr. V. J. Patel in the Bombay Council in 1917. It has been followed by Acts for Bihar and Orissa, the Punjab, Bengal, the United Provinces, the Central Provinces, Madras and Bombay City. All the Acts provide for the introduction, subject to the control of the local Government, by local option in limited areas (usually municipalities), of compulsory education for young children. In Bihar and Bengal the upper limit of age for children to whom the Act can be applied is 10. In the United Provinces and Bombay it is 11. In the Punjab also it is 11 but the local authority may alter it to 12. In the Central Provinces it may be raised as high as 14 and there is no specified limit in Madras.

All the Acts except one provide penalties for the employment of children in certain circumstances, where the Act is in force. When the first Bombay Bill was introduced, all employment of children who were covered by the Bill was made punishable. This principle was upheld by the Select Committee, and in their majority report they said : "we are not in favour of permitting the employment of children of school-going age, because it appears to us that this must prejudice their health and education" But in the final debate the clause was strenuously attacked, and an amendment was carried which had the effect of making it punishable to employ school-going children only if the employment interfered with their efficient instruction In Surat, where the Act is now in force, some children attend both factory and school. In Bengal and in Bihar and Orissa the Bills as introduced followed the original Bombay proposal and prohibited entirely the employment of school-going children. But in each case the Select Committee so amended the Bill as to allow for employment which "does not interfere with the attendance" of the child at school. So that by these Acts, and the similar Acts of the United Provinces and the Punjab, it would be perfectly possible for a child so to work in a factory as to be quite incapable of assimilating

education during school hours. In the final debate in the Bombay Council a mill-owner remarked:—"the strongest fear in my mind is that if the Bill is passed as it stands it will unduly and unnecessarily delay the application of this Act. I may certainly think it will do so in those municipalities where, at any rate, factories at present exist .... I refer particularly to municipalities like Ahmedabad and various other municipalities where there are factories, and where it is well known factories have considerable influence on the members that direct the work of the municipalities; and it seems to me that, the Act being only permissive, it is very natural that neighbouring municipalities. .... must wait to see what the other municipalities are doing for fear of losing their child labour." This states the case fairly and candidly, and the subsequent history of this Act and of the other Acts indicates that, so long as young children can be employed in factories, those who are interested in keeping them there must oppose proposals designed to give them a full primary education.

The only province in any part of which a compulsory education Act is actually in operation is Bombay. The Act has been introduced in four municipalities of which only one, Surat, has a considerable factory population. Some difficulty has been experienced in working the Act, chiefly because the parents of the children and the smaller employers are not in sympathy with it. Where, as is not uncommonly the case, parents draw advances for work to be done (for employers) by their children, it is only natural that both the parents and the employers should be anxious to evade the provisions of the Act. The results, consequently, are in accordance with expectations, and add strength to the argument that it is necessary to raise the age first, and not to wait for the introduction of primary education. This is further illustrated by the fact that none of the other Acts has so far been applied. It is true that the chief obstacle to the application of the Act in any area is probably financial, but other considerations, no doubt, have an effect.

It looks as if the problem will shortly be reduced to a simple one of ways and means. The Indian Legislature has already made a pronouncement in favour of the raising of the minimum age for industrial employment to 12. This leaves ample space for educationalists to work on. We are still a long way short of providing compulsory education for boys of 10 and under. And by the time that educational authorities are prepared to tackle the question of

introducing compulsory education for children of 12 years and over, they will probably find that factory reformers have stolen another march upon them.

A. G. CLOW

THE HIDE, SKIN AND LEATHER TRADES AND BOOT AND SHOE MANUFACTURING IN INDIA

BY

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The raw hide and skin products of India and the leather trades being so closely associated with boot manufacturing it is perhaps advisable briefly to explain the conditions as they have existed during the past six or seven years.

The Indian raw hide and skin products, placed in order of values, consist chiefly of—

A. Cow hides (kips).
B. Goat skins.
C. Buffalo hides.
D. Sheep skins.

The hide and skin, raw and tanned, exports for the year 1913-1914 were as follows, in lakhs of rupees :—

	Raw.	Tanned.
Cow hides	590	147
Goat skins	312	161
Buffalo hides	220	11
Sheep skins	26	95
	1,148	414
TOTAL	Rs. 1,562 lakhs, say 15½ crores of rupees.	

Raw cow hides found their market in Germany and Austria to the extent of 60—70 per cent., and of the raw goat skins 75 per cent. were shipped to America.

Of raw buffalo hides, about 33 per cent. were exported to America, 25 per cent. to Austria and 10 per cent. each to Germany, Turkey, Holland and the United Kingdom.

Tanned cow hides and tanned goat-skins were nearly all shipped to the United Kingdom, and of tanned sheep skins 60 per cent.

went to the United Kingdom, 20 per cent. to the United States and 15 per cent. to Japan.

Of the total exports of 1,562 lakhs of rupees, cow hides, raw and tanned, and goat-skins, raw and tanned, amount to 1,210 lakhs, about four-fifths of the total. These come under what is classed in the trade as 'light leather,' and to whichever country the raw hides or skins have been shipped, the great majority have been tanned and dressed for boot and shoe upper leathers. The development of the boot and shoe trade, therefore, offers the most suitable outlet for the bulk of India's hide and skin products. The United Kingdom, America and Germany are the chief manufacturing countries of civilian boots and shoes, and it is believed that at least 80 per cent. of civilian boot and shoe uppers are now made of **chrome leather,** either from kip, calf or goat-skins Such being the case, the development of chrome tanning should be encouraged in preference to bark tanning.

The demand for army boots, which are made from bark-tanned leathers, is small compared with the demand for civilian footwear, the uppers of which are made chiefly of chrome-tanned leathers.

The exceptional demand during the war for army boots for the Allied armies soon resulted in the great resources of India as a producer of light and medium weight leathers being recognized and relied on. The tanned cow hides (kips), tanned chiefly in Southern India, were found to be very suitable for the uppers of army boots. During the war no less than 60 per cent. of the total number of pairs of army boots manufactured in England were made of Indian leather, *i.e.*, tanned kips, for the uppers of the boots; the currying and dressing being done in the United Kingdom. The control of this industry by the late Indian Munitions Board resulted in the production being fully doubled. Unfortunately the termination of hostilities, which found England with large surplus war stock, resulted in a sudden falling-off of the demand, and left this important industry in a very precarious condition.

The temporary disaster is not confined to the tanners in Southern India, as the enormous war demand induced companies and firms elsewhere in India to embark on important undertakings and to build large modern tanneries to produce these bark-tanned kips, only to find that, when their tanneries were ready to work, there was but little demand for their products. Unfortunately

it had not been realized, firstly, that, while the normal or pre-war demand for bark-tanned East India kips might continue after the war, the largely increased production would not readily or profitably find a market; and, secondly, that the chief demand for leathers for uppers for the civilian boot and shoe trade would be of chrome-tanned, and not bark-tanned, leather, probably in the proportion of four to one.

The prospect of the chrome-tanning industry in India is very promising, both for the production of leather from light cow hides (kips) and calf skins for box calf: also from goat skins for glacé kid. The boot and shoe manufacturing industry in India will, however, still need a large quantity of **bark-tanned** buffalo leather for the soles and other parts of the bottoms of boots and shoes; also for the resoling of all footwear; and the production of this should be encouraged.

During the last two years a large number of new companies have been formed and registered to carry on the tanning and producing of leather, with an aggregate capital of nearly three crores of rupees. If all these build their tanneries as contemplated, they would have capacity to deal with quite half the number of raw cow hides and some of the goat skins which are normally exported. The product from these would far exceed the present demand in India for leathers, unless factories are established to manufacture it into boots for which there is a profitable demand.

A serious setback is being experienced at present, and many of these tanneries must now start in a smaller way than they contemplated, or defer operations What is necessary is the establishment of many boot and shoe factories in various parts of India and a few factories to make bags, trunks, travelling requisites, harness, saddlery, equipment and fancy leather articles; also all leather stores as used by railways, workshops, spinning and weaving mills, ginning factories, etc., etc, This will help the tanning industry to develop as it contemplated and provide a profitable business in India for the concerns working up the leather into footwear and articles ready for use or wear.

To produce good footwear suitable leather must be made available. As above stated, about 80 per cent. of the uppers for boots and shoes are required to be of chrome leather. This can be made from kips, calf or goat-skins according to the class of boots.

and shoes contemplated. India is only now commencing to produce chrome upper leather, for which a good demand is anticipated.

Previous to the outbreak of the war in 1914 army boot making in England, compared with civilian boot manufacturing, was a very small industry: indeed, only a part of the making was carried out by machinery, much hand labour being still employed. When the war commenced, the rapid enrolment for our army and the very large requirements of our continental allies necessitated extending the production of army boots far beyond what that small industry was capable of carrying out. It was promptly realized that, unless these hand methods were immediately superseded by the use of machinery, there would be no possible hope of meeting the enormous demands. To enable this production to be accomplished, the manufacturers of the lighter description of boots and shoes for civilian wear, which were entirely machine-made, were then induced to undertake the making of army boots. This change necessitated setting aside many of the machines then in use and replacing them with others suitable for making army boots which are much stronger and heavier.

During the first year of the war many reports were received in England condemning the defects found in the supplies of army boots. The foot-wear conditions in Flanders and France were very severe, and boots quickly became unserviceable. It was feared that, unless stronger boots were soon made available, manufacturers would not be able to keep pace with the destruction taking place. The Boot Section of the Army Clothing Department most carefully investigated the complaints and applied the remedies, with the result that the latest pattern boot, though admittedly heavy, is as nearly indestructible as leather footwear can be made. This improved army boot subsequently supplied to the army was known as the 'B.5 Pattern'; but, even after this, many alterations were introduced, and there were still further improvements made as late as September 1918. About that time the Government of India called for samples from the War Office of this latest pattern boot in its various sizes, and also for wooden lasts and card patterns necessary to guide manufacturers. These, however, did not arrive in India until May 1919.

The boots at present being supplied in England to troops are, in the author's opinion, worth several shillings a pair more than those made in 1914 and previously.

The chief improvements made in army boots are given in detail as follows, both as to the uppers and the soles, respectively.

British or Cawnpore made B·5 pattern army boot, compared with Cawnpore army boots made during the war.

Uppers.

(*i*) The legs of the army boots were formerly made in two pieces with a seam up the back and covered over with a counter. This on service has been found unsatisfactory, a very considerable number of uppers breaking away.

(*ii*) The B.5 pattern has a leg or quarter in one piece, and, in order that this should fit the shape at the back of the foot, it is moulded to the required curve so as to ensure comfort.

(*iii*) The various pieces of the upper in the B.5 boot are sewn with 5 cord linen thread passing through hot wax. This wax is absorbed into the thread, strengthens it, and is a great preservative. Most of the uppers were formerly closed with 5 cord glazed or polished thread and passed through a cold solution of wax. This solution is not absorbed into the thread.

(*iv*) The bellows tongue now introduced has a distinct advantage, as it is cut from soft leather, which easily conforms to the boot when the boot is laced and does not cause discomfort as heavy leather was liable to do. This bellows tongue makes the boot more waterproof and sand-proof.

(*v*) The joinings of the quarters to the front are reinforced by bifurcated rivets which add to the strength. These rivets have always been used in Cawnpore for Indian army boots, but not in the British boots.

(*vi*) The eyelet holes on the leg are now strengthened with a ringed eyelet. The weakness of the eyelet for many years has been a serious fault; the eyelet working out, followed by the leather tearing away at the lace-holes, has caused many boots to be condemned.

(*vii*) The outside blocked toe-cap is also a great improvement. It not only adds to the wear; but, what is probably of greater importance, it affords better fitting and more room for the toes. Without this, the toes of the boots flatten down and either cause discomfort to the wearer or induce him to take out of stores boots

two sizes larger than he should do, the result of which is that the sole curves up and quickly wears away.

Attachment of the bottom to the uppers.

(*viii*) The B.5 boot is manufactured on the rivetted-seam principle, which is considered far superior to the hand-sewn method and will stand almost any climatic conditions.

(*ix*) The insole, upper and through sole are rivetted together with 16 by 10 brass spear-point rivets which pass through these three substances and are finally clinched with what is known as the 'hook clinch.' This method is undoubtedly the best known to the trade.

(*x*) The great advantage of this whole-cut through sole is that it makes a solid foundation for the boot and for heel attaching. The whole-cut 'through' is also a great asset from the repairing point of view. The hand-sewn boot, when the welt seam bursts, is practically incapable of repair.

(*xi*) The outer sole is stitched to the 'through' with a 12 cord hot-waxed linen thread, and the outsole attachments are again reinforced by standard screw wire set seven-eighths of an inch apart, thus giving double security, and at the same time not interfering with the flexibility of the boot to the extent that the screwed boot formerly did.

(*xii*) The outside sole of the B:5 boot is reinforced with toe plates, and by protector studs which are driven into the soles and clinched before the sole is attached. This method of clinching prevents the studs from being kicked out during wear and thus prolongs the life of the boot.

(*xiii*) For mounted services, the soles of the boots are reinforced with steel bills on the tread of the boot, instead of protector studs.

For troops serving in India identically the same pattern boot has been approved as in England, but for India the weight is about 12½ per cent. less, the materials throughout being not quite so heavy. This change was made to suit climatic conditions.

As to army boots made in India previous to 1914, it may be admitted that the Indian-made British army boots were but little inferior to British-made boots. In most part of the East, and especially in sandy countries, the Indian-made boot had been

found to wear quite as well as the British. Further, as it was lighter and less rigid, it was more comfortable for marching. On the author's return to India in December 1918 he did not notice that any improvements whatever had been effected in pre-war boots of Indian make; on the other hand, the greatly increased production resulted, it is feared, in a slight falling off in quality. This can certainly be stated to be the case in the matter of the general appearance and finish of the boots.

In the autumn of 1918 the India Office asked the author if he would agree to return to India for a temporary period in order to assist the Government of India with regard to two matters. In the first place, the quantities of army boots that were being manufactured in India at the time were insufficient to meet the exceptional demand caused by the war, and the Government of India were anxious to make every effort for the development of the industry. In the second place, previous to the outbreak of the war a very large quantity of hides and skins were exported in an unfinished condition out of India, especially to Central Europe and to America, and the Government of India were anxious that the tanning industry should be developed in India in order that the raw material could be worked up in the country itself. They also desired that the foundation of an industry should be established by which the tanned leather and skins in the country might be converted into civilian footwear, for which, it was anticipated, there would be a large and increasing demand in India in future. The raw material of the country might thus be worked up locally, and employment would be provided for a large number of workmen in India.

In coming to a decision on the proposal made by the India Office, it was felt that the objects mentioned above could only be attained by the introduction into India of new and improved methods of boot-making by machinery and the rapid supply of the necessary machinery. The author was aware that 90 per cent. of the ninety million pairs of boots and shoes annually manufactured in the United Kingdom had been manufactured by machinery provided by the British United Shoe Machinery Company of Leicester. He was also aware that it was with the very valuable and important assistance that this Company rendered, not only in the early period of the war but continuously throughout the war, that army boot manufacturers in England were enabled to increase their annual output from a pre-war figure of three-fourths of a million to 15 million

pairs a year at very short notice. The opinion may safely be expressed that, without the co-operation and valuable assistance of this company, the boots required for the British and many of the Allied armies could never have been produced. Without the assistance of the British United Shoe Machinery Company, and especially the advice of Mr. Bennion, the Manager of this company, it would be of comparatively little use to go to India to develop the boot industry. It was thought advisable and necessary, therefore, to consult the company, and particularly Mr. Bennion. Mr. Bennion had previously studied the question of the boot requirements of India, but had not seriously intended taking any action in the way of meeting India's requirements for some four or five years hence, as he was then fully occupied with British requirements and had recently undertaken important obligations in South Africa and Australia. However, realizing that the author's presence in India would be an opportunity which he would not have five or six years hence, Mr. Bennion decided that if companies in India were prepared to assure him of a certain amount of business, (he named that amount as being machinery required for the making of twenty thousand pairs weekly or a million pairs a year) he would open a branch in India. With this encouragement the author decided to accept the invitation of the India Office and proceeded to India. Shortly after arriving in India he was able to give Mr. Bennion the assurance he required, and he decided to open a branch in India. This branch was opened early in 1920 with the appointment of a manager and a staff of seven British experts in boot manufacturing. A large stock of materials required in connection with boot manufacture is also kept at this branch.

Before the author reached India the armistice was signed, and the conditions were therefore completely changed. The large demand for army boots suddenly ceased, and efforts were naturally made by Government to return as soon as possible to the normal or pre-war requirements and production. So, instead of considering increased production, no more could be done, so far as concerned the one existing firm of army boot manufacturers in India contracting for supply to the Government, than to endeavour to get orders placed for new machinery for the manufacture of the latest improved type of army boots to supersede and augment the older machinery in use. The author then suggested to other firms the advisability of installing, not only machinery for the manufacture of civilian boots and shoes, but also,

in each instance, a smaller plant to make the new type of army boot, which could, when necessary, be supplemented by a few additional machines enabling these firms to undertake larger contracts to meet future urgent and war demands.

Unfortunately, the general work of developing the boot and shoe industry has been much hampered by the delay in getting delivery of machinery and building materials from England. Two years ago orders would not be accepted for delivery, at the earliest, twelve to eighteen months hence, and with no guarantee of date or price; and orders at the present time will not be accepted for delivery under a year. Further, the reluctance of banks, including even the, so-called, industrial banks, to help financially, in the form of loans for working capital, any description of industrial undertaking while they can utilize their funds in loans of a more liquid nature, deters firms from embarking on this business.

In the author's experience no trade or industry during the past twenty years has been the subject of such great improvement in the method of manufacture, coupled with rapidity of production, as the boot and shoe trade; particularly the industry in army boots during the years 1915 to 1918. The high efficiency of modern machinery lessens to a considerable extent the necessity for the employment of skilled operators. One is inclined to the opinion that the machines are almost inhuman. The pieces of leather or parts of the boot have merely to be held up to the machinery and the machines carry out the processes of manufacture.

The enormous war demands made by the Indian Government on the one army boot contracting firm necessitated the output of this firm's factories being increased about fourfold, and even then the full requirements were not met, as supplies of boots were also obtained from Australia. It may be of interest to indicate generally how the development of boot manufacturing has progressed in various provinces in India during the last two years.

United Provinces

This province has been the chief footwear-producing area, and, notably, at two factories in it great developments have been undertaken. At one a modern plant to manufacture yearly 450,000 to 600,000 pairs of the latest type of army boot has been installed and is now satisfactorily working; at another factory a complete

modern plant of machinery has been installed to manufacture yearly 600,000 pairs of boots and shoes for the civilian trade. At this latter factory a new and complete plant of machinery for the production of chrome leathers for boot and shoe uppers has also been provided. A third factory, at present only a small one, is now producing army boots at the rate of about 30,000 pairs yearly, but so far has not a complete plant of machinery, though the erection and installation of one to make 300,000 pairs yearly of army and civilian boots and shoes is contemplated. Negotiations are proceeding for the formation of two companies in other towns to start boot factories for the making of civilian footwear.

Bengal

Substantial progress has been made. A factory has been erected and machinery installed to make yearly 300,000 pairs of civilian boots and shoes and 75,000 pairs of army boots. This is a very fine and well organized factory, and work is now commencing in it. Buildings are in course of erection and machinery has been ordered for the tanning and dressing of all the leathers to be used in the making of footwear. A staff of five Europeans has arrived A similar factory of the same size and capacity of outturn, designed to produce its own finished leather and the same number of pairs of boots as the factory last mentioned, is nearly completed. The European staff of overseers has arrived. A third concern, but one smaller than those mentioned above, is making good progress towards completion and should be working in two or three months. There are one or two other concerns, on behalf of which small orders have been placed for machinery, which it is hoped will develop into large undertakings in due course.

Bombay

A complete plant of machinery has been ordered by a company to produce yearly 150,000 pairs of civilian boots and shoes. Another company has ordered a complete plant of machinery to produce annually 75,000 pairs of ladies' brocade and other fancy shoes.

Madras

A company which has existed for many years has supplemented its boot-making plant with the latest machinery and, it is understood, intends remodelling its entire plant.

In other parts of India concerns and firms are negotiating for the purchase of boot and shoe machinery, but, owing to the delay in obtaining the machinery and iron work for their buildings, no action has yet been taken. It is also probable that they are awaiting further assurance of success after they have seen the practical results of the concerns which have recently started or will shortly be starting.

It is believed that as soon as those interested in the leather trade are assured that good boots and shoes of civilian types can be made profitably in India from Indian leather with Indian labour and with modern machinery, a considerable development in machine boot-making in India will result. The representatives in India of the British United Shoe Machinery Company, Limited, are confident that boots equal to those at present imported from England can and will be manufactured in India.

To sum up the position of the leather and boot industries in India:

There exists in Southern India and the Bombay Presidency a great number of tanneries, chiefly small, but in the aggregate producing a great quantity of leather (mainly from cow hides and those not fully tanned): also a large number of tanned goat and sheep skins; most of the leather being exported to the United Kingdom. Little or no machinery is used in these tanneries at present. This trade is passing through a period of depression. In the Punjab there are seven or eight tanneries, in most cases designed to tan buffalo and cow hides and skins. At present they are producing much below their capacity, and chiefly buffalo leather; very little machinery is used and the leather is not fully tanned or set out, or rolled to render it solid and wear-resisting as good sole-leather should be. This leather finds a market in most towns in Northern India in the manufacture of the cheap bazar-made boots and shoes, also in repairing and resoling work. It could be made more valuable if machinery were applied to its preparation.

Apart from the localities mentioned above, there were in India before the war about seven tanneries where really good leather was made, the most important being situated at Cawnpore: at these the latest types of machinery were employed and with excellent results. During the war five more tanneries were started, two being very large and thoroughly up to date. Since the termination

of hostilities a further eighteen new tanneries have formed companies, obtained some capital and are in various degrees of development. Of these eighteen, about half the number have wisely decided to devote their energies chiefly to chrome tanning. The authorized capital of the thirty companies alluded to above may be stated roughly at about 3 crores of rupees, but the capital is not yet fully paid up.

At present, leaving out of the question the leather to which allusion has been made above as produced in Bombay, Southern India and the Punjab and referring only to the thirty tanneries mentioned subsequently, rather more leather is produced at present than the boot and shoe trade in India can utilize. When all these new tanneries are fully working, the leather produced in India will certainly be much more than can be converted into boots and shoes, unless many new boot and shoe factories are established. There is, in the author's opinion, a very promising future in India for boot and shoe factories, if designed to make civilian footwear for men, youths and children. The manufacture of ladies' shoes might follow later. With the adoption by Indians of Western attire, the demand for better boots and shoes will surely result.

Education and training

It is gratifying to be able to state that the Government is not neglecting the educational aspect of the leather and boot manufacturing industries in India. The Leather Trades Institute, Madras, which was opened in 1915, is run partly as a model tannery and school and partly as a research institute. The course extends over three years and the greater part of it is devoted to practical work. The training of first-year students consists chiefly in general science, both theoretical and practical, and in practical work in the tannery and curriers' shop. Second-year students are taught further general science, together with some of the simpler tests and methods of analysis used in scientific control in modern tanneries, and also receive instruction in the principles underlying the varying processes of tanning and finishing leather. Third-year students are instructed in the more difficult scientific tests and analysis in connection with the trade, and also in the details of processes used for each class of leather manufactured. On completion of the course, students who have had any experience in handling labour and in factory work should be suitable for positions as assistant depart-

mental foremen in large modern tanneries and as departmental foremen in small modern tanneries.

The Government Leather Working School at Cawnpore is intended to afford a systematic training on modern lines in the art of boot and shoe making, as well as in the manufacture of other leather articles. The course extends to two years. A branch of this school has been started at Meerut to meet the demand of the leather manufacturing industry in the United Provinces.

The Calcutta Research Tannery was established in 1919 by the Government of Bengal, with the main object of helping the development of the local tanning industry by technical research on problems connected with the manufacture of leather. Researches on tanstuffs and investigations on tanning processes, primarily with the object of adapting the modern successful methods of the West to local conditions of climate and raw materials, are the main features of the tannery. It is understood to be in contemplation, as soon as funds will admit, to extend the institution by adding—

(1) A demonstration tannery for bark-tanned products.

(2) A demonstration tannery and leather-dressing factory for chrome-tanned leather.

(3) A small boot factory, but with a complete plant of machinery to make civilian footwear and army boots, the object being—

- (i) to work up into boots and shoes the leather produced in the demonstration tanneries,
- (ii) to train students to become assistant foremen to meet the needs of the various boot and shoe factories in India,
- (iii) to give those contemplating starting boot factories in India an opportunity of seeing and being convinced that as good footwear can be made in India as elsewhere with Indian materials and labour: also of obtaining the fullest information about the machinery necessary.

All the machinery to be installed in the tanneries and boot factories will be of full standard size. So students learning to work with these will find no difficulty when employed in large factories elsewhere. A hostel to accommodate about seventy students is contemplated.

The Punjab Government has under consideration the erection of a smaller institution confined to boot manufacturing, to be worked on similar lines to the one in Bengal and with the same objects. Efforts are also being made to improve the quality of the leathers being produced in the Punjab to render them suitable for making into boots and shoes of medium and good qualities, for which there is a large demand.

HENRY LEDGARD

CHEMICAL RESEARCH FOR THE DEVELOPMENT OF INDUSTRIES IN INDIA*

BY

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Having recently been entrusted with the task of starting a research institute for the Government of the United Provinces, I have naturally been giving considerable attention to the question as to what chemical researches are likely to be most useful for the development of industries in that Province. And as I have been prevented by the circumstances of the case from doing much experimental work, I thought I could not do better, when I was asked to open a discussion at the Indian Science Congress on a chemical subject, than invite discussion on the same subject, widening the field to the whole of India. At any rate I feel sure that I am opening a discussion on a subject or group of subjects which is of great interest to many members, and I hope that I shall learn a great deal from the discussion which will follow.

On attempting to answer the question I have proposed, *viz.*, what chemical researches are most urgently required and most likely to lead to important industrial developments in India, one feels that a somewhat wider question must first be tackled; namely, what industries involving chemistry are most capable of development or likely to develop in India. The two problems are not synonymous, as there may be industries involving chemistry which are capable of large and successful development in this country without the assistance of chemical research or with very little assistance. Again, this second question, as to what industries involving chemistry are capable of development, is evidently part of a still wider question, *viz.*, that of the industrial development of India as a whole. I do not intend rigidly to separate these different questions. My object is to promote useful discussion.

* An address read at the Calcutta meeting of the Indian Science Congress on the 1st February, 1921.

I should like first to mention the chief contributions which have already been made to this subject. The United Provinces Government was early in the field, as in 1907 it considered the establishment of a technological institute at Cawnpore, of which one of the main functions was to be chemical research for the promotion of industries: and in several official communications it gave its views as to what chemical researches were most urgently required and most likely to be useful.

The Industrial Commission's report (1918) has a chapter on the deficiencies in Indian industries. It points out the order in which industries have developed in other countries, *viz.*, iron and steel manufacture first, then the production of textiles and similar goods by machinery, then the manufacture of chemicals required in these large-scale industries. It points out India's deficiency in iron and steel production which has retarded the proper development of many industries dependent on machinery. It says, "the incompleteness of our existing system of industries has been brought into prominent notice by the interference with industrial supplies from overseas due to the war. This constitutes a serious natural danger, the extent and gravity of which will be more clearly realized if we refer in detail to some of the more important manufactured materials or articles which are not at present made in India, although the basis for their production exists in the form of raw materials." The following materials and articles are then mentioned:—zinc, copper, tungsten and other ingredients of high speed steels, chromium, graphite, thorium salts for incandescent mantles, caustic soda, benzol and related products, rubber goods, tin plate, paper, drugs, dyes, essential oils. It is remarked that "in the absence of any means for producing from purely Indian sources sulphuric, nitric and hydrochloric acids and alkalis, our manufactures, actual or prospective, of paper, drugs, matches, oils, explosives, disinfectants, dyes and textiles are dependent upon imports which under war conditions might be cut off." Yet "sources of raw materials for heavy chemicals are not deficient."

Drs. Sudborough and Simonsen have discussed chemical industries in the late Indian Munitions Board's Industrial Hand-book (1919). They there lay down the general principle that in any attempts to foster the development of chemical industries in India attention should be directed, in the first instance, to industries which make use of the Indian-grown raw materials now exported to other

countries. Included in these exports are (1) the raw materials from which important fixed oils and feeding cakes are manufactured; (2) the raw materials from which valuable essential oils and medicinal drugs are prepared, and (3) various mineral products, such as chrome, manganese and zinc ores, wolfram and monazite sands. It is, however, admitted that the proposition of making India an oil and oil-products exporting, rather than an oil-seeds exporting, country is not a simple one. In addition to such industries, it is recognized that the manufacture of heavy chemicals is a key industry or group of key industries; and, as to their prospects, it is considered, firstly, that the manufacture of sulphuric acid from zinc concentrates is promising; secondly, that sufficient nitric acid for some time to come can suitably be obtained from Indian nitre (the utilization of atmospheric nitrogen is considered to be a proposition requiring careful consideration), and, thirdly, that it is doubtful whether sufficient soda to meet all Indian requirements can be obtained by the extraction of alkaline soils. The cost of the ammonia soda process would probably be too heavy to permit of soda manufactured by this process competing with imported carbonate in normal times. The electrolytic production of caustic soda and soda ash could only be made a success by utilizing the bye-products, and Magadi soda is likely to be a dangerous competitor with the Indian manufactured article; but, nevertheless, alkalis are so important that it may be necessary to protect their manufacture. It is considered essential to manufacture chlorine and bleaching powder in India.

As to the manufacture of explosives, synthetic dyes, drugs, etc., from coal-tar, it is considered that the amounts of tar available in India at present are quite insufficient to start a large coal-tar industry, and that the only way to start such an industry would be to coke all suitable coal at the pit-head.

The manufacture of permanganates, chromates and lead products, such as litharge, red lead, and white lead, are all considered to be eminently practical propositions.

Wood distillation is regarded as rather a doubtful proposition owing to the existence of large supplies of its products and the low prices likely to prevail for some time after the war.

The Indian Munitions Board held a conference of chemists in 1918 and organized as far as possible chemical research work on industrial problems. Their list of chemical researches which have been taken up includes very little under the head of heavy chemicals;

it includes a good many researches on Indian oils, such as *neem, mahua, til*, fish oils, the hardening of oils, the manufacture of glycerine and varnishes, the utilization of new Indian tanning materials and preparation of tanning extracts; the preparation and refining of essential oils, such as rose, patchouli, retivert, lemon-grass, clove, cardamom; the manufacture of strychnine, atropine and caffeine, the manufacture of chromates, wood-distillation, and various problems which are not touched on in the chemical industries article in the Handbook, such as the manufacture of starch, alcohol and glue.

The Chemical Services Committee (1919-20) have expressed the opinion that India is deficient at present in raw materials for the production of organic chemicals from coal, but consider that there is an enormous field for the production of carbon compounds from vegetable products. They explain that they do not only refer to such products as oils from oil-seeds, indigenous dyes, drugs and essential oils, but consider that there is a great field for the production of new products of greater economic value by the conversion of organic compounds present in Indian plants.

From these references to what has already been said on the subject it is obvious that the subject can be looked at from several points of view. In the first place, it may be argued that, as India is essentially an agricultural country, exporting large quantities of agricultural products, the most obvious industrial development is to carry out in this country the processes to which those products are at present submitted on arrival at their destination. This argument recommends the pressing of oil seeds, the manufacture of soap, glycerine and varnishes, the tanning of hides and skins, the extraction of alkaloids and so on. In the second place, it may be argued that industries are bound to develop in all countries according to a definite sequence; iron and steel first, then machinery, then the textile and similar industries, and then the chemical industries to meet the requirements of these. In the third place, the great war has brought into prominence the disadvantage at which a country may be placed unless it is self-supporting as regards essentials, such as food and clothing and munitions of war. From this point of view it may be necessary for the State to protect and foster certain key industries.

At first sight it appears as though these different arguments might lead to different recommendations as to the chemical industries which should first be developed in India. If this is the case,

it is obvious that there is something wrong with one or other of these general principles. But I think I shall be able to show that when carried to a conclusion all the arguments lead to the same recommendations. My own employment during the war, when I had the pleasure of helping in the British manufacture of synthetic dyes, naturally makes me inclined to look on the problem of Indian industrial development from the last point of view, *viz.*, to see that key industries are placed on a satisfactory footing. Fortunately India is essentially self-contained as regards food-stuffs and textile fibres; but she is by no means self-contained as regards military requirements, such as explosives and synthetic dyes. This points to the desirability of establishing the coal-tar industry in this country; for it is from coal-tar that all countries obtain their high explosives, their synthetic drugs and their synthetic dyes. The war has taught us how intimately inter-connected are the manufacture of these three groups of chemical products. I find, however, that most chemists who have given their attention to the development of Indian industries discourage the idea of attempting the manufacture of explosives, drugs and dyes from coal-tar. They say that India does not produce sufficient tar; the tar is deficient in the most valuable ingredients; it is doubtful whether England will succeed in manufacturing these products in the face of German competition, and so it would obviously be absurd for India to try.

Let us take first the most obvious military necessity, *viz.*, explosives. What quantity of explosives does India consume? What quantity is she likely to require in the event of war? How much does she manufacture at present and how much does she import? I have not got any official returns as to production and consumption, but I calculate that India is producing less (probably far less) than 4,000 tons of explosives annually and importing less (probably far less) than 5,000 tons. I have arrived at the figure for India's production of explosives from the total consumption of nitrates and nitric acid in the country. The majority of the nitrates are no doubt used as manures, so that my figure is the maximum possible, which is probably many times greater than the actual. And for India's imports of explosives I have had to go by the figures for imports of explosives as private merchandise *plus* total Government imports of arms, ammunitions and military stores, excluding firearms. Here, again, my figure is the outside limit which is probably far greater than the actual figure. But these figures are no higher

than the most moderate estimate of India's probable requirements in the case of war. Before the war England produced 18,000 tons of explosives annually. By 1916 the amount had risen to 200,000 tons and by the end of the war to about 350,000 tons. As we are on the subject of coal-tar, let us consider first those explosives which are manufactured from coal-tar, *i.e.*, high explosives, such as picric acid and T.N.T. Ammonium nitrate is also very important and can also be manufactured in connection with the coal-distillation industry. During the war England produced about 1,500 tons of picric acid and T.N.T. a week, as compared with 2,500 tons of propellants, such as cordite, and 3,000 tons of ammonium nitrate. As a most modest estimate, we may assume that India should be able to produce 4,000 tons of picric acid and T.N.T. per annum and might require many times this amount.

At present India makes about 500,000 tons of coke and 8,000 tons of tar per annum. It is estimated that, if all the coke were manufactured in bye-product recovering plants, about 16,000 tons of tar would become available. This is a low figure, based on a note prepared by Mr. W. J. Alcock for the Indian Munitions Board. I think it is probably based on practice in the Bengal Iron and Steel Company's coking plant. It is well known that the yield of tar depends very much on conditions of coking, so that too much importance should not be attached to the low yield. But as the benzene and toluene content of tar is only about 1 per cent., we could not get more than 80 tons of benzene and toluene a year if all the tar at present produced were distilled for this purpose. The amounts of tar available in India under present conditions are obviously quite insufficient to produce all the explosives required. But Drs. Sudborough and Simonsen estimate that, if scrubbing plant for recovering benzene and toluene from the coke-oven gases were introduced, an additional 2,000,000 gallons, or about 10,000 tons, of crude benzol could be obtained. With this quantity of crude benzol available the manufacture of high explosives becomes a practical proposition. Drs. Sudborough and Simonsen's estimate of 10,000 tons of crude benzol from plant producing 500,000 tons of coke is high, but, even during the war, the yield of crude benzol has been much increased by improved washing. According to the Proceedings of the Institute of Civil Engineers for March 1918, 13.5 lbs. of benzene and toluene can be obtained from 1 ton of coal. Calculating from this figure, plant producing 500,000 tons of coke could

yield 9 million pounds, or about 1 million gallons, of benzene and toluene. This quantity of benzene and toluene would suffice to produce the quantity of explosive which we calculated as India's minimum safe production. In peace these hydrocarbons could be utilized largely for the production of dyestuffs. The Germans showed during the war the close connection between the manufacture of explosives and synthetic dyes and drugs. Plant used in peace time for manufacturing dyes can readily be turned in war time to the production of explosives. Germany's large dye manufacturing concerns were so employed during the war. India's maximum annual importation of dyestuffs was 8,900 tons. This is a figure of about the same order as her requirements in the way of explosives and her present productive capacity in the way of benzene and toluene from her coking operations. Her production of iron and steel is bound to increase. Her coal resources have not yet been fully exploited and she already produces 20 million tons per annum. The amount of iron ore and other requisites for iron and steel manufacture are unlimited. India produces at present about 250,000 tons of iron and steel and imports 1¼ million tons annually. If she produced only as much as she now requires the blast furnaces would consume at least 1½ million tons of coke, and this would at once triple the possible production of benzene and toluene.

My calculations may be wrong, but, so far as benzene and toluene are concerned, I think India is in a sound position to undertake the manufacture of explosives, synthetic dyes and drugs.

Nor is India by any means dependent on her coking ovens for a sufficient supply of aromatic hydrocarbons to manufacture all the explosives and synthetic dyes she may need. During the war a good deal of attention was given to the production of these hydrocarbons from petroleum, and it is now recognized that this is a practical proposition. Ordinary scientific literature contains very little information on the subject. But in 1907 Jones and Wootton pointed out in the Chemical Society's Transactions that Borneo petroleum contains a considerable quantity of aromatic hydrocarbons, and we learn from a paper * in the Journal of the Society of Chemical Industry that a source of supply of toluene for British explosives was developed during the war by the Asiatic Petroleum Company from Borneo spirit. The third volume of the Society of

* J. S. C. I. 1919. 366 R.

Chemical Industries' Annual Reports informs us that in Russia aromatic hydrocarbons for dyes and explosives have long been obtained by cracking petroleum oils. Nikiforoff took out patents on this subject in 1886, 1887, 1901 and 1902. In the United States of America, also, a great deal of attention was paid during the war to the production of aromatic hydrocarbons by cracking petroleum.

Mention has already been made of the Chemical Services Committee's suggestion that some of the numerous organic compounds produced so freely in the vegetable world in India could be subjected to a variety of chemical processes to yield a range of chemical products. Explosives and dyes might be produced in this way, *e.g.*, tannins are produced in India in enormous quantities in barks, fruits, etc. Ordinary tannin or tannic acid is converted quantitatively into gallic acid on hydrolysis. Gallic acid is said to be converted quantitatively into salicylic acid or benzoic acid by reduction with zinc dust and ammonia.* These substances might serve as starting-out materials for the preparation of explosives, dyes, etc. I do not wish to be more explicit at present, but I may say that experiments I have in hand have already shown that aromatic hydrocarbons, ample for India's requirements in the way of explosives, dyes and drugs, can be obtained conveniently and cheaply from indigenous materials other than coal distillation bye-products. I hope shortly to patent these methods of production and get them taken up on a large scale. Private firms of explosive manufacturers have already been considering the manufacture of high explosives in India.

It may, however, be argued that the successful manufacture of explosives, synthetic dyes and drugs requires not only a sufficient supply of cheap aromatic hydrocarbons but many other chemicals in considerable quantity, such as sulphuric acid, nitric acid, caustic soda, alcohol, wood spirit, formaldehyde, chlorine, nitrite, zinc, ammonia, etc., and that the want of these renders impracticable any proposition for manufacturing dyes and explosives in India. Let us consider these chemicals in detail.

Sulphuric acid

The manufacture of this acid has up to the present been seriously handicapped by the absence of suitable sulphides for roasting, and

* Guignet. Bulletin de la Société Chimique. (3) 7,153.

imported sulphuric has been used. India's present consumption of sulphuric acid is somewhere between 10 and 40 thousand tons per annum.

Owing to the importance both of sulphuric acid and zinc "the Government of India is interesting itself in the proposal to erect zinc-smelting works at Jamshedpur, where the zinc concentrates from Bawdwin in Burma will be dealt with and the spelter and sulphuric acid yielded made available to the Tata Iron and Steel Company for their own purposes and for subsidiary companies. The plant, which it is proposed to erect with a loan from Government, will be capable of dealing with 25,000 tons of zinc concentrates, and the estimated output is 10,000 tons of spelter per annum"* and 32,000 tons of sulphuric acid. The iron and steel industry requires large quantities of sulphuric acid for recovering ammonia from the coking plant and for pickling iron plate for galvanizing and tinning. Most countries consume very large quantities in the manufacture of superphosphates. There is no reason to fear that the production of sulphuric acid will exceed the demand, but it should meet all requirements for some time, including requirements for the manufacture of explosives and dyes. I have no information as to the amount of zinc concentrate which may eventually become available. At present this scheme has a serious defect from the military point of view, as a blockade of the Bay of Bengal would cut off the supplies of zinc concentrates. A railway from Burma to India is in contemplation, but I do not know whether it is likely to be built immediately. It seems remarkable that it should be necessary to go over seas, even as far as Burma, for sufficient suitable sulphur compounds for the manufacture of sulphuric acid. During the war the German Government is said to have subsidized heavily an enterprise for the manufacture of sulphuric acid from gypsum,† and it is stated that sulphuric acid can be manufactured in any quantity by this process at the same cost as from imported pyrites. On consideration, it seems almost certain that in any country the bulk of the element sulphur will be in the form of sulphates. Sulphides are essentially unstable compounds and on weathering are converted with sulphates. It is certain that there are sufficient natural sulphates in India to supply all the sulphuric acid likely

* Cotton. Handbook of commercial information for India, p. 234.
† J. S. C. I. 1916, 1058, U. S. Pat 1197 331 of September 5th, 1916.

to be required either now or in the future. I hope shortly to take out patents for the manufacture of sulphuric acid from readily available natural sulphates.

Nitric acid

At present India exports about 26,000 tons of nitre, consumes about 4,000 tons and imports about 1,700 tons of Chili saltpetre. Her imports of nitric acid are negligible. With a sufficient supply of sulphuric acid there will be no difficulty about producing the nitric acid required for explosives and dyes.

Caustic soda

The quantity of alkalis required for the manufacture of dyes and explosives is comparatively small, and India's requirements in this respect could easily be met from the salts contained in alkaline soils. Drs. Sudborough and Simonsen's remarks on the question of alkali manufacture have already been quoted at some length. That it is a key industry there can be no question. The present consumption of alkalis is comparatively small (35,000 tons of soda imported in 1917-18) but increased production of cotton goods and soap is bound to multiply many times the present demand for alkalis. An increased demand for cotton goods is one of the most certain results of India's development, and, with an increase in the production of iron and steel and machinery, there is no doubt that increasing quantities of cotton goods will be manufactured in this country. The present value of cotton goods consumed per head of the population is Rs. 2-12 per annum. There can be no doubt that this will be multiplied several times in the near future and that the bulk of the goods will be manufactured in this country. This will increase proportionately the demand for alkalis, which are used for scouring cotton goods.

It is doubtful whether it will be feasible to get all the alkalis required from alkaline soils. Mr. Srivastava, Industrial Chemist to the United Provinces Government, estimated that 5,000 tons of soda ash per annum could easily be obtained from *reh* soils near Cawnpore. There are large tracts of such soils in the United Provinces and the Punjab, and there would be no difficulty in manufacturing all India's alkali requirements from these soils if Mr. Srivastava's estimate is correct. On the other hand, I hear

that a recent survey by the Geological Department of the alkaline earths of Rajputana gave disappointing results, although these soils have generally been considered a more suitable source of soda than the soils of the United Provinces and the Punjab. Some more quantitative information about the alkaline soils of the United Provinces and the Punjab is urgently required to decide the lines on which this key industry must develop.

Alcohol

As India is essentially an agricultural country and exports large quantities of material, such as grain, which are used in the country of destination for the production of alcohol, there seems no reason to doubt that industrial alcohol could be successfully produced in India. Dr. Fowler's selection of *mahua* flowers as the most suitable starting-out material has been criticized, but I have not time at present to discuss this point

Wood spirit, formaldehyde and acetic acid

I have already mentioned that the writers of the article on chemical industries in the late Indian Munitions Board's Handbook look on wood-distillation in India as a somewhat doubtful proposition, on the ground that very large plants for wood-distillation were set up for war purposes and will flood the post-war market with wood spirit and acetic acid at low prices. But these products are all dangerous chemicals, and shipping freights on them are very high, so that a comparatively small plant meeting India's requirements would possibly be a sound proposition, although manufacture on a large scale for export might not be feasible.

I hope I have said enough to show that we do not really arrive at different conclusions by approaching from different points of view the problem of the development of India's chemical industries. If we start with the idea that the first and most obvious thing to do is to work up our vegetable products to a certain extent before export, we find that to do this we want cheap acid, alkalis, spirit, etc. If we start with the idea that there is only one possible sequence of development of industries which has been followed in all countries which have developed, and must be followed in all countries which are developing, *viz.*, iron and steel manufacture first, then machinery, then textiles, etc., with chemical industries

as hand-maidens called in as required, we find again that cheap acids and alkalis are the first chemical requirements, and the manufacture of explosives, dyes and drugs necessarily follows for the utilization of bye-products and to meet the requirements of the textile industry. It we start with the idea that first and foremost we must see that India's military requirements are met so that she could withstand a blockade, then we decide that explosives must be manufactured in the country from materials all available in the country. This leads again to the necessity for developing the iron and steel industry, for the manufacture of acids and alkalis, the utilization of coking bye-products and the manufacture of dyes and drugs along with the explosives.

I find that I have spoken chiefly about the development of chemical industries in India and very little about chemical research for the development of industries. But that seems to me the proper way of looking at the subject. First let us decide what has to be done, and then let us see how chemical research may assist. At first it may seem that there is not much need for research to instal in India such well-known industries as the manufacture of iron and steel, sulphuric acid, alkalis, coking bye-products, etc. But my discussion of these problems has already suggested several researches, *e.g*, the question of the utilization of sulphates for the manufacture of sulphuric acid, a survey of India's alkaline soils, and the possibility of finding other sources than coal-tar and coke-oven bye-products for the manufacture of aromatic compounds, such as explosives, dyes and drugs. These are researches for the decision of most important and fundamental questions. The establishment of any manufacture involving chemical reactions on a large scale is much assisted by chemical research.

Problems are certain to arise from the fact that the materials available, or climatic conditions or other factors, are different from those in the countries already carrying on these manufactures. These are platitudes which the British find it hard to recognize but which are, nevertheless, recognized to a greater extent than before the war. So far I have spoken of research in connection with the fundamental industries. For others which are not, perhaps, of such vital importance there are any number of chemical problems appealing, perhaps, more strongly to the chemist, whose interests are primarily scientific, *e.g.*, lac-dye is thrown away at the present time. Apparently the fastness to alkalies of its dye-

ings is not quite good enough to meet modern requirements, but it is an anthraquinone derivative, and so belongs to the same family as our most valuable mordant and vat dyes. Comparatively simple chemical treatment might convert it into a valuable dye. In Indian turpentine we have a cheap source of pinene in any quantity. The chemical relationship between the different members of the terpene group is very close, and it seems quite feasible to convert pinene into the unsaturated open chain compounds which are the chief constituents of essential oils and perfumes. Amongst the vegetable products of India the organic chemist can find any number of problems of interest, and very likely of profit.

E. R. WATSON

TECHNICAL AND INDUSTRIAL EDUCATION IN BENGAL

A BRIEF OUTLINE OF THE PRESENT POSITION

BY

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Under recent orders of the Government of Bengal the control of technical and industrial institutions, with two important exceptions, has been transferred from the Director of Public Instruction to the Industries Department, and the present time is opportune for a brief statement showing the present position of technical and industrial education in the Presidency. The two exceptions in the Government order are the Bengal Engineering College, Sibpur, and the Dacca School of Engineering. The transfer of the control of these two institutions has been reserved for further consideration. It appears possible, however, that they too may be placed under the general control of the Department of Industries, and in any case in surveying the present position they cannot conveniently be excluded.

Civil Engineering

This falls naturally into three grades :—

(1) higher training leading to the B. E. degree,

(2) training to the Overseer or Upper Subordinate grade, and

(3) training up to the Sub-Overseer or Lower Subordinate grade.

Higher training is confined to the Bengal Engineering College, and the present course consists of four years at college followed by one year's practical training. The Public Works Department Reorganization Committee have proposed to take one year from the college course and add it to the period of practical training on works. They have also proposed that the age of entrance should be lowered, and have made various other recommendations on the subject of the admission standard and other matters. The whole question

was referred by the Government of India to the Government of Bengal a year or two ago, and doubtless the matter is now under the consideration of the Government of India in the light of the replies received from local Governments. The admission standard of most of the present candidates at Sibpur is the I. Sc., First Division, or the B.Sc.

There are two institutions in Bengal teaching up to the Upper Subordinate standard, *viz.*, the Bengal Engineering College and the Dacca School of Engineering. Previously this course was open to all candidates who had passed the Sub-Overseer examination, and thus consisted of a total course of four years. This arrangement has now been changed on the recommendation of the Joint Technical Examination Board, and there is now a three-year Upper Subordinate course and a separate two-year Lower Subordinate course. Only a limited number, not exceeding 20 per cent., of those who have passed the Lower Subordinate examination are admitted to the second year of the Upper Subordinate course. Candidates who reach the Upper Subordinate standard by this channel will thus spend four years on the course. By separating the two courses entirely it has been possible to arrange a more specialized syllabus for each, and the new syllabuses are now followed at all the institutions concerned. After passing the examination, Upper Subordinates spend a year on approved practical training on works before getting the complete certificate. The certificates are given by the Joint Technical Examination Board on the results of the examinations held by this body. The Public Works Department Re-organization Committee have recommended that there should be only one grade of subordinates for the purposes of the Public Works Department. From the requirements that they specify it is evident that the grade they require is approximately equivalent to that of the present Upper Subordinate. Objections have been raised by this Committee and by other authorities to the training of engineers and subordinates together in one and the same institution, and it has been suggested that, ultimately, the Upper Subordinate classes at Sibpur might be abolished, and all subordinates be trained at the Dacca School of Engineering.

Sub-Overseers and Lower Subordinates are at present trained at the Dacca School of Engineering and three smaller technical schools. The Joint Technical Examination Board have suggested that, eventually, the training of this class of subordinates should be confined

to the Dacca School and, perhaps, one or two improved technical schools. Although only one grade of subordinate will be recruited for the Public Works Department in future, yet there is a considerable demand for a subordinate with lower qualifications, such as are required for many of the lower appointments under district boards, municipalities and private employers. The training of this grade might be carried on in the small technical schools and, at any rate for the time being, in the Dacca School as well.

Surveying

Instruction in surveying is under the supervision of the Survey Education Advisory Board, the President of which is the Director of Surveys, Bengal. The chief survey school is at Mainamati near Comilla. The site was selected with a view to giving diversified experience in surveying and levelling, the school being situated among a group of low hills. The full course extends over two years. In addition there are survey classes at the Dacca School and at three of the smaller technical schools, the course extending over a year and leading up to an examination conducted by the Board. Candidates who have passed this examination can either seek employment forthwith, or they may proceed to take the second year of the course at Mainamati and appear for a higher examination at the end of the course. An attempt has been made to provide facilities for practical training in mine surveying to students who have passed from the Mainamati School, but it has been found very difficult to obtain suitable facilities.

Mechanical and electrical engineering

There is a three-years' course in mechanical and electrical engineering at the Bengal Engineering College, Sibpur, leading up to an examination held by the Joint Technical Examination Board, and students who have passed through this course appear practically always to obtain suitable employment without difficulty. In most cases the employment is in electrical engineering posts. The whole question of the training of mechanical engineers has been thoroughly discussed during the last year or two by a committee of the Governing Body of the Sibpur College, and subsequently by a special committee appointed by Government to advise regarding the co-ordination of the training of railway apprentices with the

Sibpur courses. In their report the latter committee proposed a complete scheme, under which ordinary apprentices in railway workshops would undergo a suitable training in the shops together with a theoretical training in the necessary subjects at a technical school at the workshop or elsewhere: after four years of apprenticeship a selected number of the best apprentices should be sent to the Sibpur College for a further specialized training extending over about a year and a half. The scheme was fully worked out as it applied to the Kanchrapara workshops of the Eastern Bengal Railway only, but it is expected that, eventually, it will, with necessary modifications in each case, be adopted by other large railway workshops near Calcutta. It is proposed that there should be a single board of control, which would hold a single admission examination for all apprentices and supervise the training generally.

In order to provide for the large number of apprentices attending the various engineering workshops in Calcutta, an evening technical school has been established for many years. Certain rooms at the Government School of Art are now utilized for this purpose. The present teachers are very well-qualified; but the arrangements have been most inadequate for the proper instruction of these apprentices. A special committee appointed by Government has considered the question and has recommended the erection of a suitable building on a central site. Proceedings are now being taken for the acquisition of the necessary land, and it is hoped that the building will be commenced within the next few months.

Boys are accepted for artisan training in carpentry, blacksmith's work, etc., at the Bengal Engineering College workshops and also at the Dacca School of Engineering and the smaller schools. There are also several excellent industrial schools managed by different Missions.

Mining

All mining education in Bengal, as well as in Bihar and Orissa, is under the control of a Mining Education Advisory Board, the President of which is the Chief Inspector of Mines. The instruction given is of three grades, *viz.*,—

(*a*) *Higher instruction.*—This is undertaken at the Bengal Engineering College, Sibpur, where there is an Indian Educational Service Professor of Mining and a suitable staff and equipment. These classes were started in 1905. For some years the number

of students was small, but the classes are now well filled. Many passed students have obtained the Colliery Manager's Certificate. Practically all passed students appear to get suitable employment, and many have risen to very responsible and well-paid positions.

(b) *Part-time classes at three centres in the Bengal coalfields.*—These are conducted by well-qualified lecturers and the course extends over two years. The teaching is conducted in English, and the classes are attended by young men of fair education, both Europeans and Indians, employed in the coal mines. An examination is held at the end of the course and certificates are issued by the Mining Education Advisory Board. A Sub-Committee appointed by Government to consider the question of mining education issued a report in 1913 recommending the development and improvement of these local classes as well as the formation of a school of mines at Dhanbad. The question of the development of the classes has been under discussion for some years, the delay being mainly due to difficulty in arranging for a suitable financial contribution from the mining community to meet a grant from Government. The difficulty has, however, at length been got over, and the scheme for improvement is now being taken in hand. The proposed school of mines at Dhanbad will not be required in view of the proposed institution of an Imperial school of mining and geology in that district.

(c) *Local classes conducted in the medium of Bengali.*—These classes are of an elementary character. They are held at three centres in Bengal and are attended by men of slight education employed in the coalfields.

Weaving

The centre of instruction in this subject is the Serampore Weaving Institute.

For higher-grade students, mostly of about the matriculation standard, there is a course which has recently been extended to three years and which includes drawing, designing, dyeing and other subsidiary subjects in addition to weaving.

In addition, there are practical classes for artisans both at Serampore and also at half-a-dozen other schools scattered over the Presidency. These are attended almost exclusively by men and boys who are practical weavers and who come to improve their knowledge.

In order to reach the weavers in outlying parts of the Presidency, six peripatetic instructors are employed, each of whom is assisted by an artisan weaver. They give instruction for a few months in one district and then proceed to another. A system of Government loans has been introduced for helping passed pupils to purchase improved looms on the completion of their course. The system has now been in operation for a few years and has proved a success. The loans are repaid with fair regularity.

The Serampore Weaving Institute has hitherto occupied a hired building together with some temporary sheds. It has been provisionally decided to acquire an extensive site at Lillooah, some three miles from Calcutta, and to remove the Serampore Institute to this site, where suitable buildings will be erected.

Commercial education

The Calcutta Government Commercial Institute at present occupies a hired building, no provision having yet been made for its permanent accommodation. There is a full-time two-year day course which includes English, commercial geography, arithmetic, and book-keeping, with typewriting and shorthand as optional subjects. The number of students has very largely increased in the last two or three years, and some classes have had to be duplicated or even triplicated. The entrance qualification is the passing of the University Matriculation. The Institute is under the control of a Board. The appointment of a Principal was sanctioned over a year ago by the Secretary of State, but a suitable candidate for the appointment has not yet been sent out from England. There is in operation a system under which other schools can obtain affiliation to this Institute and can send up candidates for its examinations. Twelve schools are now affiliated. In addition to the day course of the Institute there are evening classes in various subjects, intended for youths who are employed during the day.

Art

Instruction in this subject is given at the Government School of Art, Calcutta, which comprises the following departments :—(*a*) elementary, (*b*) industrial, for lithography, wood-engraving and modelling, (*c*) for draftsmen, (*d*) for painting in the Indian as well as in the Western style, and (*e*) for teachers.

Students from all parts of India attend the school, and passed students appear to be very successful in securing appropriate employment. The school occupies a splendid position, and the Government Art Gallery is in the same building.

W. H. EVERETT

INDUSTRIAL DISPUTES DURING THE FIRST QUARTER OF 1921

The three tables attached have been prepared in the Labour Bureau of the Government of India. They are based, as regards Bengal, principally upon statistics collected in the Department of Industries there. For other provinces, official reports and press accounts have both been utilized, and, while every endeavour has been made to secure accuracy, the figures of persons employed and of days lost are only approximate in many cases. It is probable that several strikes have escaped notice and the information as to the results of the strikes cannot always be guaranteed. The statistics can, however, be regarded as sufficiently reliable to illustrate the extent of industrial unrest and the tendencies at work.

The first two schedules are arranged upon the same plan and show the strikes tabulated (1) by provinces (2) by industries. The third column shows the number of workers actually involved, and the number of the fourth column represents the total number of working days lost by these workers.* Under 'demands' each dispute has been entered according to the main demand of the workers. The column 'personnel' includes all strikes where the chief object was the reinstatement or dismissal of an employee. The other headings explain themselves. Lockouts are not shown separately. The few lockouts that have occurred are difficult

* "The jute mills worked by agreement for 5 days only (Monday—Friday) per week throughout the quarter; and it was decided during the quarter to go on to a 4 days' week (Monday—Thursday) from the 1st April. For the purpose of arriving at working days lost during the quarter the Saturday of each week is accordingly calculated as a *dies non*. It is part of these short-time agreements that a mill that loses time owing to a strike is allowed to make good the defect by working for one extra day during the further term of the agreement that may still be unexpired. In view of this fact the apparent loss of working days implied in the ensuing statement is presumably greater than the actual loss of working days; the results of a strike, within calculable limits, being simply a loss of holidays to the employees.

Six jute mills employing 50,500 work-people closed down during the quarter for a total in all of 16 working days owing to inadequate coal supply. Under the short agreements referred to above it is open to the managements concerned to make good the time so lost by working one extra day per week during the further term of the agreement." (*From Department of Industries, Bengal.*)

to distinguish from strikes. Where, for example, the men attend a factory and because of some grievance refuse to work, and the management closes the factory, it is difficult to say in which category this should be placed. In the column showing the results, disputes have only been shown as failures if the workers obtained no concessions, and they have only been shown as successful if the workers gained in full their main object. As, however, in strikes for pay, the workers frequently demand a good deal more than they intend to secure, a large number of the compromised strikes should be regarded as successful.

The third table is designed to show the course of industrial unrest from month to month.

It will perhaps be best to refrain from elaborate comments on the figures and to leave readers to draw their own deductions. The interesting facts brought out by the statistics include :—

Table I—(*a*) the marked contrast between province and province (*e.g.*, Burma and United Provinces) as regards the magnitude and duration of strikes.

(*b*) the differences as regards settlement (*cf.* Bengal and Bombay).

Table II.—The contrast between textile industries and the more important non-textile industries as regards the duration of the strikes.

Table III.—(*a*) the steady decline in the numbers of strikes,

(*b*) the strong tendency to increase in their duration,

(*c*) the increasing proportion of unsuccessful strikes.

TABLE I.

Provinces.	No. of disputes.	Numbers involved.	Days lost.	Demands.					Results.				
				Pay.	Bonus.	Personnel.	Leave and hours.	Others.	Successful.	Partially successful.	Unsuccessful.	Not known.	In progress.
Bengal . . .	49	88,473	1,259,148	31	2	3	3	10	4	24	16	2	3
Bihar and Orissa .	5	17,678	127,112	4	..	..	..	1	..	4	..	..	1
Bombay . .	27	38,717	416,518	12	7	7	..	1	8	3	15	..	1
Burma . . .	11	9,768	52,174	10	..	..	..	1	..	4	1	4	2
Central Provinces and Berar	2	3,000	15,000	.	2	..	..	..	1	..	1	..	..
Madras . .	7	8,198	157,808	2	1	1	..	3	..	4	3	..	..
Punjab and Delhi .	4	1,610	77,660	3	..	..	..	1	..	2	..	..	2
United Provinces .	11	17,807	484,905	2	5	3	..	1	..	1	6	..	4
TOTAL .	116	185,251	2,590,325	64	17	14	3	18	13	42	42	6	13

TABLE II.

Industry.	No of disputes	Numbers involved.	Days lost.	DEMANDS.					RESULTS.				
				Pay.	Bonus.	Personnel.	Leave and hours.	Others.	Successful.	Partially successful.	Unsuccessful.	Not known.	In progress.
Cotton and woollen mills.	27	35,434	394,308	9	7	10	..	1	9	4	13	..	1
Jute mills . .	9	38,300	168,700	2	..	3	2	2	1	3	4	1	..
Engineering works.	13	18,011	345,365	11	1	..	..	1	..	5	7	1	..
Railways (including workshops).	10	27,310	805,710	7	..	..	..	3	..	1	5	1	3
Mines . . .	8	15,812	82,058	8	..	..	..	..	..	7	..	..	1
Tramways, taxis and carriages.	7	8,170	146,850	3	2	..	..	2	..	5	2	..	..
Municipal . .	6	5,406	16,518	3	..		..	3	..	6	..	..	..
Printing presses .	5	1,366	43,578	4	.	..	.	1	1	1	1	..	2
Shipping and docks	5	6,340	33,734	4	1	..	.	..	..	1	1	..	3
Unskilled labourers	5	2,199	2,249	3	1	..	1	..	2	..	3	..	..
Tanneries . .	3	4,225	121,250	1	2	.	..	..	..	1	..	..	2
Oil works . .	3	10,743	145,820	2	1	..	.	..	..	2	1	..	..
Posts, telegraphs and telephones.	3	925	20,355	1	.	.	..	2	..	2	1	..	..
Ordnance factories	2	6,500	205,000		.	.	..	2	..	..	1	..	1
Cigarettes and *biris* makers.	2	1.300	24,700	2			..	..	..	2	..	..	..
Miscellaneous* .	8	3,210	34,130	4	2	1	..	1	..	2	3	3	..
TOTAL .	116	1,85,251	2,590.325	64	17	14	3	18	13	42	42	6	13

* Miscellaneous includes strikes in a sugar mill, a paper mill, a saw mill, three rice mills, a shellac factory and a strike of tailors.

TABLE III.

—	January.	February.	March.	Whole quarter.
Disputes in progress at beginning .	20	15	21	20
Fresh disputes begun	42	34	20	96
Disputes ended	47	28	28	103
Disputes in progress at end . .	15	21	13	13
Numbers affected	82,003	89,332	79,527	185,251
Days lost	694,484	867,993	1,027,848	2,590,325
Results of disputes ended :—				
Successful	7	3	3	13
Partially successful . . .	26	8	8	42
Unsuccessful	14	17	11	42
Not known	..	..	6	6

SUMMARY OF INDUSTRIAL INTELLIGENCE FOR THE QUARTER ENDING 31st MARCH, 1921

Assam

Better marketing of cottage products.—The Government Emporium of Cottage Products and Central Stores for Cottage Workers was opened at Gauhati during the quarter. Its main objects are :—

1. To advertise on modern lines the indigenous products of cottage workers.
2. To sell these products in return for a small commission, in and outside Assam and in the overseas market, to the best possible advantage to the producers.
3. To induce local craftsmen to manufacture goods suitable for the foreign market by finding a ready sale for such goods.
4. To supply local craftsmen with necessary raw materials, implements and accessories at reasonable prices.

Paper.—A company with a capital of Rs. 20,00,000 has, at last, been formed for the manufacture of paper from the Assam Savanah grasses. The directors include some prominent men of Assam, such as the Raja of Gauripur, and also scientists like Sir P. C. Ray and Rai Bahadur Chunilal Bose, late Chemical Examiner to the Government of Bengal. The company have been able to secure the services of an expert in the person of Mr. K. Saikia who has already successfully erected and run a grass paper-pulp factory elsewhere. A return of over 34 per cent. on the subscribed capital is anticipated. A convenient factory site is being acquired and the factory buildings are expected to be ready towards the beginning of 1922.

K. L. BARUA,
Director of Industries.

Bihar and Orissa

Board of Industries.—The personnel of the Board of Industries has now been settled and the first meeting was held in Calcutta on April 7th.

Coal supply.—The supply of coal, so far from having improved, continues steadily to deteriorate. During the last two months of the quarter a general paralysis seems to have seized the railways, and small industrialists have practically received no coal at all. This seems to have been due partly to the strikes at Lillooah and on the Oudh and Rohilkhand Railway, both of which held up large numbers of waggons, and partly to the evasion of the X class system by some colliery owners. Whatever the cause, the results are deplorable and industries dependent on coal have nearly all come to a standstill.

Labour conditions.—On the whole, during the last quarter labour conditions have improved. The year opened with several strikes in progress and forebodings of many others. In one or two cases strikes were fought to a finish and the victory rested with the employers, who had already made the utmost concessions which they could afford. A few new strikes occurred during the period, but March closed, so far as is known, with only one or two strikes in progress and those of little importance. Although, therefore, the feeling of unrest among manual workers has by no means departed, the situation at the time of writing appears more hopeful.

B. A. COLLINS,
Director of Industries.

Bombay

Staff.—During the quarter ending the 31st March the staff of the Department of Industries remained at the strength described in the February number of the Journal. Provision had been made in the budget of 1921-22 for three Assistant Directors and twelve Circle Officers, but the former item was cut out by the Legislative Council while the second was reduced so to provide for only five Circle Officers.

Assistance to local industries.—In the prevailing industrial depression Mr. F. E. Bharucha, the Assistant Director resident at Ahmedabad, found little in the shape of new enterprise to engage his attention. He advised an important local millowner in the design and set-out of a new cotton spinning and weaving mill; and for this work a fee was charged by the Department. He also gave assistance to two important British enquirers who are interested in the output of local hand industries, especially calico printing,

carpet weaving and the manufacture of silk and other high class fabrics. I have hopes that with one of these gentlemen, who has a long standing interest in the manufacture of artistic and high class fabrics and a more recent one in the production of fast dyes, the Department has begun a connection which will not merely assist it materially in finding markets for the industries just mentioned but which will raise the standard of their design and workmanship. At present Mr. Bharucha is engaged in designing a dyeing shed for a small company at Malegaon in the Nasik District. Nearly the whole population (about 15,000) of this town depends, directly or indirectly, on handloom weaving, and the successful introduction of fly-shuttle looms in the town has added greatly to its prosperity. This is reflected in the initiative of a few better-to-do individuals who are trying to organize local dyeing on modern lines. If British dye manufacturers could be induced to take a practical interest in developments of this nature it would go some way towards assisting them to meet successfully the competition of other countries.

Utilization of bitterns.—The investigation of the utilization of the mother-liquor or bitterns of the Kharaghoda Salt Works has lately been held up for want of a suitable apparatus for experiments in the recovery of epsom salts from the bitterns before the removal of the magnesium chloride. The magnesium chloride itself still presents a minor problem, in that the crystals, although perfectly white, show signs of discoloration when they are fused preparatory to filling the drums in which they are transported from the works. Further work is indicated in the report of the Scientific and Industrial Research Department in England on the analyses of a large number of samples which were sent last year to the Principal Chemist, Government Laboratory, London. These analyses show that the brines and bitterns contain quantities of potassium and bromine compounds, sufficient to warrant further investigation of the possibility of extracting these on a commercial scale. It indicates the poverty of our resources in India that the analyses here had failed to find potassium in the brines or bitterns. and when it was proposed to make another test after receipt of the analyses from London, it was found that a chemical essential to the analyses could not be obtained in India. In view of the commercial results already obtained and the analyses from London, as well as the possibility that further chemical survey may show the presence of other commercially valuable materials in workable quantities, the Department

of Scientific and Industrial Research has suggested that tests should now be made locally on a semi-large scale. This has opened up an administrative problem of some interest, as hitherto the costs of the investigation have been met by the provincial Government, while the revenue from the industry in the shape of royalty and income tax has gone wholly to the Imperial Government. The general question thus arises on what lines industries subsidiary to the salt industry, which is under the control of the Government of India, should be developed in the provinces.

Casein.—The small demonstration casein factory at Anand in Gujarat is working satisfactorily, but a market for the improved casein, which will give full value for the improvement, is still under investigation.

Trawling.—The steam trawler *William Carrick* which was purchased in England arrived in Bombay on March 13th after a voyage from Milford Haven of 36 days, of which 29 days only were actual steaming days; a good performance for a vessel of this type. As it was necessary to overhaul the vessel, make some small alterations and otherwise prepare her for trawling, she was placed in the R. I. M. Dockyard, which was unable, however, to undertake the work on account of work in hand for the Navy. The trawler was then transferred to the Mazagon Dockyard, where, after her engines had been opened up, the workmen went on strike, so that the beginning of trawling operations has been delayed.

Weaving instruction.—The Weaving Section, which at present runs three schools and eight demonstrations, is in many instances now re-visiting areas previously worked: the results usually justify these repeat visits and the use of fly-shuttle sleys steadily increases. One weaving school has been taken over by a District Local Board as part of a local industrial school, and the services of a weaving master and assistant have been loaned to the Board for this purpose.

Reparation dyes.—Little more reparation alizarine dye is expected, and as sufficient supplies now appear to be coming from England on the British Alizarine Co.'s account, the control of the distribution of any future consignments of reparation alizarine dye will be unnecessary. The dye market is generally very dull, and, although enquiries for reparation aniline dyes have been more active since the breakdown of the reparation negotiations in London, the sales are still small.

Coal supply.—The coal difficulty continues, and a scheme for central supply to glass factories has broken down owing to the inability of the authorities to give such a priority for wagon supply as would give a reasonable assurance that wagons would be actually forthcoming.

R. D. BELL,
Director of Industries.

Burma

The Department practically came into being at the beginning of this quarter, but it was not until well into February that an office was obtained in the business part of the town and its equipment is not yet complete. Early in March the Director started on a tour in India, going first to Bombay to consult with Mr. F. H. McLeod, C.B., from the Board of Trade in England, then on the return journey stopping at Nagpur to see the Central Provinces system of inland trade registration and recording of prices current, and finishing up in Calcutta where work was done with His Majesty's Senior Trade Commissioner, the Director-General of Commercial Intelligence, the Director of the Geological Survey, the Director of Industries, Bengal, and many business houses. The Director also went over the Engineering College at Sibpur and an institution for the blind. The advantage of this tour has been very marked as Burma is somewhat isolated from other provinces, and, as regards matters of intelligence, practical lines of demarcation were laid down with the Trade Commissioner, the Commercial Intelligence Department and other Departments of Industry.

Intelligence.—A considerable number of enquiries continue to come in as the Department becomes better known, and quite a large section of the community is already finding the Department, small and inadequate as it is, of some use. It cannot be of the use which it should be until other expert staff, such as an industrial engineer and an industrial chemist, has been appointed. The Department is also useful as a liaison department between the public and the other departments. Members of the public frequently do not know to which department of Government they should in the first place apply. It is easy to come in to the office of the Industries Department which is in the centre of the town to get the necessary information.

Labour.—One of the chief reasons for a tour in India by the Director was to draw up in consultation with Mr. F. H. McLeod,

some sort of organization in Burma for ascertaining the real facts about the conditions in which labour works and to get together facts from which index figures can be worked out. There have been some fifteen strikes in Burma during the quarter in two of which there is some reason to suspect political origin. In the majority of cases, however, the cause has been purely economic. The most important is that of some 8000 strikers in the Burma Oil Company's refineries at Syriam, Dunnedaw and Bogyok. A committee of arbitration under the presidency of Mr. James MacKenna, C.I.E., Development Commissioner, was appointed. Increases of pay were given ranging from Rs. 5 in the case of men receiving Rs. 15 to Rs. 25 to Rs. 18 per mensem in the case of men receiving Rs. 141 to Rs. 150 per mensem. These increases were to apply to all employés in the refineries except the clerical staff. The clerical staff were given the rates of pay in force for the corresponding grades of the clerical establishment in the main office. The Committee consisted of five, being two representatives of the owners and two of the workmen with a Government nominee as president. Prior to the appointment of the Committee the Burma Oil Company and their employés had come to an agreement that the grievances of the employés should be considered by a committee. They returned to work before the committee sat. In connection with the syces' and coachmen's strike in February, during which there was some intimidation, one S. A. S. Tyabji and his coachman were charged with conspiracy and prosecuted; the trial resulting in an acquittal. There were two strikes in motor works and three connected with river boats or launches. The strike on the railway which started in Rangoon affected only the menial establishment, and though it spread over a good deal of the country it only appeared in individual stations and did not last long. Since the close of the quarter a further strike has broken out in the Insein workshops of the Burma Railways Company which is still unsettled. The greater number of the smaller strikes were unimportant and the men returned to work before long, and frequently without having obtained more than the promise that their grievances would be considered.

Technical education.—No technical education officer has yet been appointed but the Government have constituted a committee to consider the re-organization of the Insein Engineering School on which Mr. Heaton of the Sibpur Engineering School and Major Sandes of the Roorkee Civil Engineering College have been asked

to serve as members. The Director will take the opportunity of the meeting of this committee to ask for their advice regarding technical education generally throughout Burma.

Industrial engineering.—Proposals for the appointment of an industrial engineer are shortly being submitted to Government, and the urgent need for such an officer is emphasized by the cases in which the aid of the Department has already been sought. Among others the Department has been asked to advise on the purchase of white sugar plant, sugar crushing and jaggery boiling apparatus, cotton spinning and weaving machinery and also regarding mica winning appliances and heavy-type motors for cargo boats.

Industrial chemist.—The position is the same as with the industrial engineer, but the need for a chief chemist's services is becoming increasingly urgent because it is necessary soon to determine how far the chemical institute will be able to assist

(1) in the teaching of the technical institute,
(2) in work for other departments, such as the Forest Department and the Geological Survey Department, and in mining and metallurgy.

Industrial survey.—One officer of the Burma Civil Service has been placed on special duty in the Department for employment as Circle Officer and he has commenced the industrial survey of the Bassein Division. There is yet no superior officer to take charge of the industrial survey, but in conjunction with the Census Commissioner certain questionnaires have been drawn up in the form of cards which will give the Department some information as regards large industrial establishments, cottage industries, bazars and trade routes.

The Sales Depôt of Burma Art and Craft Ware is not yet in working order, but a considerable number of orders amounting in value to several thousand rupees have come in. As these are mostly cash with order they are being executed without waiting for Government's orders regarding a permanent advance for the Sales Depôt.

Fisheries Department.—The Director took the opportunity of being in Bombay to ascertain from the Director there the cost of equipping and importing a marine trawler fitted with cold storage plant, and also consulted the Marine Biologist, who has been lent by the Board of Fisheries at home to the Bombay Government, as to the lines on which similar work could be undertaken in Burma.

Rubber industry.—The Development Commissioner has decided that the rubber industry should come more properly under the Agricultural Department than the Industries Department.

Trade registration.—Government has ordered an improved system of inland trade registration to be drawn up by the Director of Industries in conjunction with the Commissioner of Settlements and Land Records, in whose office the work has hitherto been done, and part of the reason for the Director's tour in India was to study similar systems in the provinces of India.

Mines.—Government has appointed the Director of Industries to be the representative of the Government of Burma on the Governing Body of the School of Mining and Geology at Dhanbad and has ordered him to attend the first meeting to be held before the end of April. No separate mines section has, however, yet been created in the Department of Industries, though the need for the services of a mining expert is becoming apparent.

H. B. HOLME,
Director of Industries.

Central Provinces and Berar

Weaving.—451 fly-shuttle sleys have been sold to weavers during the three months January, February and March. The demand for dobbies, shuttles and pirns is well maintained, and the arrangements for their distribution are appreciated by the weavers. There are indications that the introduction of the fly-shuttle among village weavers will lead to co-operation amongst them for the purchase of raw material and the sale of finished goods. Another development is the village factory run by a landed proprietor. In this factory persons who are not weavers by caste have been taught to work the fly-shuttle loom with success. The factory is very well run, and the foremen employed are weavers from Kamptee. The owner of the factory has opened a cloth shop in a neighbouring town and reports that he sells all his output without difficulty.

Leather Expert.—The efforts to improve local methods of flaying and curing by means of local demonstrations continue and have produced good results. Small local tanneries could be trained. The grant was made last year and will be available when financial conditions improve. At present the Department of Industries in

this Province cannot make much progress as money cannot be found for it.

Schools of Handicrafts.—The Inspector of Industrial Schools is being provided with a portable projector and suitable films for instructional purposes. It is hoped that the part-time courses provided for apprentices in the railway and other workshops in Nagpur will become more attractive. At present very few apprentices attend these courses, but it has been observed that these few are very keen and regular in their attendance.

Electricity.—Efforts are being made to induce local bodies to take a greater interest in lighting and power schemes. The provision of suitable factory sites in this Province is a matter which is closely connected with the improvement of the water supply; and this, in turn, depends very much upon the inclusion of pumping systems in schemes for light and power. Khandwa will have electric light and power within the next few months, and the Jubbulpore scheme has, after many difficulties, now been taken in hand by a Bombay syndicate.

Glass factory.—The Department is endeavouring to help Mr. A. V. Pandit, a local man, to open a glass factory at Gondia. Mr. Pandit has served a term of apprenticeship in the Talegaon Glass Factory near Poona. This enterprise is being hampered by the difficulty in obtaining Bengal coal.

H. R. CROSTHWAITE,
Director of Industries.

Madras

There is little to record in regard to industrial expansion in the Madras Presidency during the quarter under review, as, owing to the continuance of financial stringency, no new companies were formed and no new industries were established.

Board of Industries.—Meetings of the Madras Board of Industries were held in January, February and March. The following questions, amongst others, were included in the agenda of the meetings and considered by the Board:—

(1) The development of the manufacture of vegetable oils in this Presidency.

(2) The acquisition of land in the vicinity of railway stations for industrial development.

(3) The creation of a Provincial Industrial Service.
(4) The provision of facilities for instruction in mining and geology, and the question of recruiting a mining geologist for the Department of Industries.
(5) The administration of the Electricity Act, and the inclusion of an electrical engineer in the staff of the Department of Industries.
(6) Proposed legislation in regard to banking law.
(7) The appointment of a commercial assistant to the Director of Industries and the control of commercial education.
(8) An application for assistance in experiments in manufacturing glass in Madras.
(9) The question of the establishment of a chemical research institute for the Madras Presidency.
(10) The establishment of a soap factory and technical institute for the training of students at Madras.
(11) The appointment of an advisory board of directors and of a manager for the Karala Soap Institute, Calicut.
(12) The improvement of railways in the Madras Presidency from the point of view of industries and trade.
(13) The appointment of a dyeing assistant.
(14) The desirability of establishing a commercial and industrial museum at Madras.
(15) The provision of additional hand and power drills and pumping sets.
(16) Scholarships tenable at the Indian Institute of Science, Bangalore.
(17) The revision of the rules for the levy of fees for work done in connection with industrial undertakings and pumping installations.
(18) The desirability, or otherwise, of appointing honorary correspondents of the Department for each district.
(19) The desirability, or otherwise, of forming District advisory industrial committees.
(20) Financial assistance by Government to organized industries or in the establishment of new industries.
(21) The desirability of the Department encouraging and assisting exhibitions of local manufactures and products and improved machines and appliances.

Departmental conference.—A conference of the Head-quarters and district officers of the Department of Industries was held during the month of January, at which a large number of subjects relating to industrial development were discussed. The conference, which extended over a week, was also attended by the Chief Conservator of Forests, the Registrar of Co-operative Societies, the Director of Agriculture and Dr. G. J. Fowler of the Indian Institute of Science, Bangalore.

Electric power schemes.—Concessions have been applied for to establish electric generating stations at Salem and Bellary with a view to supply electric power to the various factories already established or under contemplation at those places. The development of these schemes is being closely watched by the Department. A scheme to utilize the power of a waterfall in Guntur District to work marble quarries is under investigation.

Aerial ropeways.—The question of providing improved facilities for the transport of forest products, and of passenger traffic between the hills and the plains, is under consideration, and at present two schemes for providing aerial ropeways connecting the Shevaroy Hills with Salem, and Kotagiri in the Nilgiris with Mettupalayam, are under investigation.

Exhibitions.—The Department has recently participated in three exhibitions, at Mangalore and Tellicherry on the west coast and at Nandyal in the ceded districts. At these exhibitions improved weaving machinery and appliances, including hand-looms, were shown, as well as hand and power boring sets and pumping plants. Samples of soaps manufactured at the Kerala Soap Institute, Calicut, and inks and glues manufactured at the Industrial Laboratory, Coonoor, were also exhibited. The Kerala Soap Institute was awarded gold medals for its exhibits of soaps at Tellicherry and Mangalore, whilst the Textile Branch of the Department of Industries was awarded a gold medal for the improved appliances exhibited at the Mangalore Exhibition.

Publications.—A pamphlet based on information supplied by the Board of Trade in regard to rates of import duty leviable in foreign countries on oil-seeds and allied products has been published and circulated to firms interested in the trade. A similar pamphlet in regard to Indian hides, skins and leather goods is under preparation. The Industrial Chemist has written a report on the subject of paper and pulp production in the Madras Presidency which will

shortly be published as a Bulletin of Indian Industries and Labour. The preparation of a bulletin on the coir industry of the Madras Presidency has also been taken in hand.

Chrome-tanning extracts.—Considerable difficulty has hitherto been experienced by Indian tanneries in arranging for the supply and manufacture of a chrome-tanning liquor that would give regular and constant results in practice. The staff and senior students of the Leather Trade Institute have been working on the problem of evolving a suitable extract during the last session, and have constructed a plant which is capable of producing a liquor of exceedingly constant quality at a lower cost than by any of the methods usually employed. A bulletin giving particulars of the experiments and plant and the results obtained is under preparation and will, it is hoped, be ready for publication by the end of April.

Tile factories.—The manufacture of roofing tiles of the Mangalore pattern has hitherto been restricted to the west coast, but there seems no reason why such tiles should not be manufactured on the east coast and at other places in the Presidency. Samples of clay have been obtained from several places and have been examined, or are under examination, by the Superintendent of Pottery, Sir J. J. School of Arts, Bombay. Proposals are under consideration by private parties to establish such factories at Bellary, Salem and other places.

Sand for glass.—The question of the suitability of the sand available in the vicinity of Madras for the manufacture of superior glass-ware is once more being investigated, and the results of a number of analyses which have been carried out on various samples have been communicated to the agent of a British firm of manufacturers.

Sugar factory.—The question of the development of the sugar industry is receiving considerable attention. The Kistna Sugar Works Ltd. has been formed to manufacture sugar from jaggery at Masulipatam in the Kistna district, and the formation of a large company to manufacture sugar from cane in South Arcot district is under consideration. It is proposed to instal an improved 5-roller mill at the Government Experimental Factory at Pallapalayam with a view to ascertain whether it is possible to improve the percentage of extraction. The results obtained up to the present from a 3-roller mill have been disappointing, as the yield did not exceed 66 per cent., a result which shows little improvement on that obtained from the ordinary bullock-driven mill.

Cottage industries.—The District Assistant Directors have been requested to institute a survey of existing cottage and village industries. It is proposed that the Department of Industries should work in close touch with the Victoria Technical Institute, so far as the development of industrial arts is concerned, particularly in regard to the organization and supply of artistic industries in the Presidency in respect of which the Victoria Technical Institute acts as a central sales organization. Proposals to establish subsidiary museums and depots in important centres, such as Bezwada and Madura, which would act as feeders to the Institute, are under consideration. A list has been drawn up of articles in demand, which includes brassware, lacquer and silverware; cocoanut, stone and wood carving; embroidery, earthenware, ivory and inlaid work, toys, palampores, carpets and rugs, and the Assistant Directors have been requested to undertake regular surveys of the industries connected with these articles.

Textiles.—The departmental manufacture of model looms and improved weaving appliances has now been organized and placed on a more satisfactory basis by the Textile Expert The Department, besides arranging for the manufacture of looms and improved appliances, including winding, warping and sizing machines required by the several peripatetic weaving parties, also undertakes orders for such machinery and appliances from the public. Estimates have been drawn up by the Textile Expert for the addition of a spinning mill and a number of power looms to the Coimbatore Jail. Arrangements have also been made for the provision of instruction in improved methods of weaving to the criminal tribes of Kallarnad.

Government have approved the proposal of the Director to utilize the weaving section of the Madura Technical Institute for the following purposes :—

(1) for training new maistries and maistries of peripatetic weaving parties,

(2) for training teachers in weaving employed in schools,

(3) as a central distributing factory of sleys and other improved apparatus connected with the hand-loom industry,

(4) as a central distributing factory for the supply of looms and special warp and weft preparation machinery,

(5) for the preparation of warps for sale to weavers, and

(6) as a permanent museum of all types of hand-woven fabrics, improved looms and accessories.

Industrial alcohol.—The Industrial Chemist is carrying out enquiries in connection with the production of power alcohol, and it has been proposed that the researches should be carried out in association with Sir Frederick Nathan, the Power Alcohol Investigation Officer in England. The Department has offered to assist and carry out researches for the Fuel Research Board in the following directions :—

(*a*) Compilation of information regarding the products available.

(*b*) Specific experiments with reference to tropical products available in this Presidency.

(*c*) Experiments under tropical conditions regarding the use of mixtures or denaturants.

(*d*) By acting as official intermediaries between the Power Alcohol Committee and the Department of Bio-Chemistry at the Indian Institute of Science, Bangalore, in connection with the investigation of alchohol production by direct fermentation of cellulose.

Paper manufacture.—A private syndicate was formed some time ago to establish a paper mill on the banks of the river Godavari, and it is understood that the machinery required for the production of 10 tons of paper pulp and 3½ tons of news-printing paper per diem has now been ordered and that the necessary steps have been taken to recruit the staff required.

Miscellaneous.—In order to ascertain whether lime of high quality suitable for the paper and other industries is available, samples of limestone have been obtained from various sources and forwarded to the Chemical Examiner for analysis and report.

The question of arranging for the commercial exploitation of Kittool fibre and the utilization of *Bohinia* fibre is under investigation.

The question as to whether it would be practicable to arrange for the melting and re-manufacture of foreign bangles is under investigation, and in this connection the possibility of reconstructing the furnace in use by the country bangle-maker, or of evolving a new design with a view to obtaining a higher temperature, is being examined.

L. B. GREEN,

Assistant Director of Industries

Punjab

Industrial Museum.—Since the beginning of this year the preparation of show cases and the collection and display of exhibits have been taken in hand. Certain unavoidable delay occurred owing to the ill-health of the Curator. Experience in this connection showed the extremes of business temperament among manufacturers in the Punjab. While a few are eager to supply samples free and even to pay for show cases, unfortunately the majority require not only cash payment for their sample exhibits, but persuasion. This, however, is an incentive to the cause of the Industrial Museum, as latent manufacturers are made known, and this is expected to develop the idea of publicity in the minds of local manufacturers.

New industries.—The Punjab Pharmaceutical Works, Ganpat Rai Buildings, Gowal Mandi, Lahore, have recently started a neatly equipped factory, with automatic machinery and electric sterilization, for the production of all kinds of tablets, also their own printing press for tablets.

A simple and cheap threshing machine has been patented and manufactured by L. Ram Chand Khanna & Sons, Changar Mohalla, Lahore. The Department is now in touch with the Military Oat Hay Farm, Okara, for trials. The capacity is said to be 50 maunds per diem, and the price Rs. 200.

The Punjab Cement Tile Works, Fleming Road, outside Mochi Gate, Lahore, recently commenced the manufacture of smooth, waterproof, hard-wearing paving tiles to any colour, size or shape

The Shri Radha Krishan Acid Factory, Grand Trunk Road, Lahore, will shortly manufacture sulphuric acid of the best quality on the 'Cascade' system.

The Department has obtained a sample of rustless steel for experimenting made by the well known cutlery firm, The Krishna Cutlery Works, Wazirabad.

The fly-shuttle hand-loom and hosiery machine has recently much increased in number in various parts of the Punjab, the increase being especially marked in Ludhiana. Generally, the hand-woven fabric from either coarse counts or extra fine counts can compete in price with the power loom for equal qualities; but for medium counts the power loom has the advantage.

Industrial Advisory Boards.—Local Advisory Boards consisting of five or six members now exist at Lahore, Amritsar and Ludhiana. Applications for sanction have been made for similar boards at Rawalpindi, Sialkot, Multan and Ambala. A provincial board will follow later.

Industrial survey.——This continues to make progress, and as a standing routine duty of all Industrial Surveyors, definite subjects are selected from time to time. Vegetable oils and their products are now under survey. This will now be shortly followed by cotton, silk and wool. Secondly, routine subjects are simultaneously prepared, and in this connection 'Raw Materials of the Punjab' is now in hand.

E. A. SCOTT,
Director of Industries.

United Provinces

Technological Institute.—As early as 1907 Sir John Hewett called a representative committee to consider how to ameliorate the industrial backwardness of this province. His Excellency the present Governor was the Secretary of the conference. The question of a technological institute was then broached, but remained in abeyance for thirteen years on account of the war and other pre-occupations. A committee was appointed to go into the question last year, and a report containing its recommendations has now been published.

It has been recognized that researchers should do some teaching: that the two branches of research and teaching are not to be divorced but so organized as to inspire each other. A three years' course has been recommended for the training of works chemists in oil, leather, dyeing and treatment of textiles. It is proposed that a certain number of students be trained in the methods of industrial research. They should have passed the B.Sc. Examination, and it is proposed that they should receive a stipend of Rs. 75 per mensem, opportunities being afforded them of receiving a practical training in workshops under factory conditions. A suitable building with lecture rooms, laboratories and workshops is being put up in the industrial capital of the United Provinces, Cawnpore.

Mechanical and electrical engineers.—A representative Committee has completed its deliberations for settling the curriculum of a college for training mechanical and electrical engineers and foremen. Roorkee-trained civil engineers have earned a well-deserved

for training in improved processes of weaving for periods of from one to three months. The weavers bring their own warps and are taught the use of the fly-shuttle looms. They buy the improved sley very readily. The outturn has been so promising that local carpenters have started manufacturing the improved pit looms, and it is estimated that fly-shuttle looms in use in Mau exceed one thousand. Even *purdanashin* women in neighbouring districts have taken up fly-shuttle weaving on realizing the larger outturn to be obtained from it and the shorter hours of work required to produce a day's wage. The most common cloth on which the looms are working is *dhoti*-cloth of 32 counts Japanese yarn. The woven cloth is sent to Eastern Bengal, Dinapore and Madras. When it is realized that double the quantity of cloth can be woven on the improved looms, it is clear that the enterprising *Julahas* of these parts have considerably increased their income. A committee has been appointed under the presidency of the Registrar of Co-operative Societies to enquire into the working of the fixed and peripatetic schools and to report on their comparative utility.

Scissors and lock industry.—A detailed investigation was carried out into the conditions under which Meerut scissors and Aligarh locks are made, and steps are being taken to organize the industries and secure a better finish to the articles turned out by establishing a model factory.

Gold thread industry.—An ex-student of the weaving institute, Benares, has put together a small machine for weaving gold and silver tape *gota*. Improvements have been suggested in the mechanism, and as he is a poor student, a recommendation has been made to the Board of Industries to give him monetary assistance for further experimentation.

Pandit Raja Ram Lele has succeeded in plating silver *kalabathu* with gold and thus a grant given by the Board of Industries has borne fruit. Effort is being made to introduce a draw bench for the purpose of reducing the silver bar to wire of medium size and subsequently reducing the wire as far as to 40 gauge. At present the work is done by hand and is slow.

Coal situation.—There is a universal wail about the coal shortage, and industry is already suffering considerably from this cause.

V. N. MEHTA,
Director of Industries.

MISCELLANEOUS NOTES

THE BLEACHING OF SHELLAC

The action of sunlight can decolorize a solution of shellac as well as can animal charcoal. Shellac can also be deprived of its colour by pouring its alcoholic solution into potassium hypochlorite solution or by passing chlorine into a potash solution of shellac. But these methods do not find commercial application.

Theory of the process.—Bleached shellac is prepared from ordinary shellac by the action of hypochlorite of soda on the alkaline solution for the purpose of removing the red-brown colour of the lac. The lac dye is bleached very quickly, but the yellow colour of the erythrolaccin is more persistent, and a greater or smaller quantity survives the bleaching entirely; hence the bleaching is due to the more or less complete destruction of the erythrolaccin.

Description of process.—The method employed for bleaching shellac was as follows :—

One pound of soda ash was dissolved in three gallons of water and heated to boiling point in a circular wooden vat fitted with lead piping for steam-heating. Five and a half pounds of ground shellac (button lac) were then added slowly. The shellac dissolved in the alkaline solution, leaving only a small amount of suspended matter (impurities floating) on the surface. 5½ lbs. of bleaching powder were then dissolved in 10¾ gallons of water: to this mixture 4½ lbs. of soda ash were added. The whole was well stirred and filtered. The clear solution so obtained is sodium hypochlorite.

This solution was then added to the hot shellac solution. The addition was effected gradually, and in small portions towards the end, with short intervals between the additions.

Characteristics of the product obtained.—The product obtained by bleaching shellac is white in appearance, and is rather crisp and brittle. Bleached shellac in the form of a dry powder is ready for immediate use for the preparation of shellac varnish, this variety being largely employed in the United States. Bleached shellac

contains no wax but still contains water, and gradually undergoes a change into a modification insoluble in alcohol and alkalies. This change cannot be prevented. It will take place with greater ease at high temperatures. Bleached shellac should be used promptly. It dissolves in the same solvent as orange shellac: the solution is milky white, the milkiness being due to the suspension of insoluble shellac wax. In alcoholic shellac solutions the wax partly settles in time. Bleached shellac should be stored in as cool a place as possible and should be kept under water. This precaution is necessary to avoid blocking of shellac in summer weather.

The samples of bleached shellac obtained in this laboratory were examined, firstly, with a sample of bleached shellac from England and, secondly, with a sample manufactured by Messrs. D. Waldie & Company, Konnagar. The following statement gives comparative results. The solubility figures show the enormous deterioration which bleached shellac undergoes on exposure to light and air:—

Sample of bleached shellac.	Colour.	Hardness.	Solubility in cold alcohol (62 5 per cent)
English make. (The sample had been kept in our laboratory for a long time.)	White (Very slightly dark at the core.)	Very crisp .	12 1 per cent. soluble.
D. Waldie's make. (The shellac was stored under a slightly acid solution.)	Dark . .	Rather plastic	...
Our own make. (Kept exposed to light and air for six months.)	White . .	Crisp . .	56 6 per cent. soluble.
Our own make. (Freshly made and kept under water for 15 days.)	Do. . .	Rather plastic	Almost complete.

The materials used in the experiment analysed as follows:—

1. Button lac (shellac).

   Iodine value . . . . . 3·01 (by Wij's solution).

   [Allowable limit of iodine value for T. N. shellac . . . . 14—17. [Iodine value increases as percentage of rosin in shellac increases. Shows freedom from rosin.]

2. Soda ash . . . . 85 per cent. Na_2CO_3.

3. Bleaching powder contains 25 per cent. available chlorine on an average.

Calculation of costs of experiments as carried out :—

	Rs.	a.	p.
Shellac (button lac).			
Five and a half lb. at Rs. 275 per maund	18	6	0
Soda ash 5½ lb. at Rs. 6-8-0 per cwt.	0	5	3
Bleaching powder 5½ lb. at Rs. 71 per cwt.	3	8	0
Steam	Negligible.		

(The very small amount of steam used is only a very minute fraction of that required in the works for pumping water and for other purposes.)

	Rs	a	p.
Labour. One workman at 8 annas a day for an 8 hour day	0	8	0
	22	11	3
	Or, say, Rs. 23.		

Taking the yield of bleached shellac as 5½ lb. less 0·22 lb., or 4 per cent. less (3 per cent. being lac wax and 1 per cent. insoluble matter) or 5·28 lb., the cost of production per lb. of bleached shellac works out at Rs. 4-6-0. The cost will be very greatly reduced if the production of large quantities of bleached shellac is taken in hand and also if cheap chlorine be made available in quantity.

The calculation has been made with inflated prices of shellac and bleaching powder, such as are current at the present time. In 1903-4 the price of shellac rose to 230 shillings per cwt.; in 1908-9 the price was reduced to 60 shillings per cwt. Quite exceptional prices were reached during the war, even 400 shillings per cwt. being exceeded. In 1918 arrangements had been made in England by which the shellac required for munitions was obtained direct from India at 144*s.* 6*d.* per cwt. for all Government contractors who could produce evidence that they required the supplies for Government orders.

Composition of bleached shellac.—According to Tschirch, bleached shellac contains chlorine, so that the iodine absorption is materially modified. Fraymouth* says that an additive compound of shellac with chlorine is obtained.

This problem will shortly be taken up for investigation at the technical laboratory, since a few samples of bleached shellac made here did not on examination reveal the presence of chlorine.

* "An argument for a change in the Lac industry" Indian Munitions Board, Industrial Handbook, 1919.

Bleached shellac: its preparation as a local industry.—Mr. Fraymouth says "it is unlikely that white lac will ever be manufactured in India because it remains hard only at low temperatures." India is the great shellac-producing country of the world, and it should really be her monopoly to manufacture white lac (bleached shellac). If chlorine is rendered available in large quantities and as a cheap commodity, then there is absolutely no reason why India should not be the seat of manufacture of bleached shellac. The most vital drawback to its local manufacture is the scarcity of chlorine, or, for the matter of that, cheap chlorine.

White shellac is at present unknown and unobtainable in the country, and owing to its rapid deterioration, unless made into polish, is not imported. Several of the Indian timbers cannot be properly finished without the use of bleached shellac, and a considerable addition to the uses of certain woods is sure to follow if the matter of polish can be handled locally.

S. T. GADRE

Investigation of cotton stalks from India as a paper-making material

I. The samples of cotton stalks which are the subject of this report were forwarded to the Imperial Institute of the United Kingdom, the Colonies and India by the Director of Industries in the Punjab in order that their value for paper-making might be ascertained.

DESCRIPTION

The samples were as follows:—

(1) "1 farm-selected broad Leaf"—Weight 1¼ lb.
(2) "Mallisoni No. 24." Weight 1½ lb.
(3) "4 F Cotton." Weight 2 lb.
(4) "Rosea No. 87." Weight 11 oz.
(5) "285 F Cotton." Weight 1¼ lb.

These five samples consisted of cotton stalks, devoid of leaves, from 5 feet to 7 feet in height and having a diameter of five-eighths of an inch to seven-eighths of an inch at the base. The stalks,

which were fairly hard and woody, were covered with a brown, rather fibrous, bark and had a narrow pithy core.

RESULTS OF EXAMINATION

Representative portions of the five samples were mixed together and examined as a paper-making material with the following results, which are shown in comparison with those obtained with a sample of cotton stalks from the Central Provinces :—

—	Stalks from the Punjab	Stalks from the Central Provinces
	Per cent.	*Per cent.*
Moisture	10·7	10·2
Cellulose	* 40·3	† 44·1
Ash	3·0	2·6

* Equivalent to a yield of 45·0 per cent. from the dry material.
† Equivalent to a yield of 50·1 per cent. from the dry material.

The ultimate fibres measured from 0·6 to 1·2 mm. in the case of stalks from the Punjab, and from 0·5 to 1·0 mm. in the case of those from the Central Provinces, the average in both cases being 0·8 mm.

The stalks were treated with caustic soda under conditions similar to those employed in the manufacture of paper pulp on a commercial scale, with the following results, which are expressed on the material as received :—

Stalks from	Caustic soda used		Conditions of boiling		Parts of soda consumed per 100 parts of stalks	Yield of dry pulp
	Parts per 100 parts of stalks	Parts per 100 parts of solution	Time Hours	Temp. °C		
Punjab	22	5	9	160	14 6	34
Central Provinces	22	5	0	160	14 6	37·5

It was necessary in both cases to use a large quantity of caustic soda in order to break up the stalks completely. Treatment with 22 per cent. of caustic soda was required in order to obtain a satisfactory pulp, which bleached to a pale cream colour and furnished paper of fair quality. The yield of pulp from the Punjab sample was less than that from the stalks from the Central Provinces, but the paper produced was of similar character.

REMARKS

The results of the investigation show that when treated by the caustic soda process these Indian cotton stalks yield paper pulp of fair quality which can be bleached to a pale cream tint. The yield of pulp is rather low, and it is necessary to employ larger quantities of caustic soda than in the case of esparto and similar grasses, but the results are sufficiently promising to justify further consideration.

In connection with the possible utilization of the stalks for paper-making in India there are several points which need investigation. One of the most important is the cost of collecting the stalks from the field and conveying them to the factory. On account of the bulky nature of the material it would be essential for the factory to be situated in a locality where large supplies of the stalks are available at a minimum cost for transport, and it would be necessary to have an ample supply of water and facilities for the transport of the pulp to the paper factory. The cost of the necessary fuel and chemicals will also have to be ascertained. In addition it would be advisable to have large scale trials carried out, preferably in India, in order to determine the results obtainable on treating the stalks on a commercial scale.

II. The sample of cotton stalks which is the subject of this report was forwarded to the Imperial Institute by the Director of Industries, Central Provinces, in order that experiments might be made to determine the value of the material for the manufacture of paper and cardboard, as suggested in the Director's letter No. 1924, dated the 26th September 1919.

In addition, preliminary trials have been made at the Imperial Institute to determine the yield and nature of the products obtainable from the stalks by dry distillation.

DESCRIPTION

The sample weighed 134 lbs. and consisted of reddish-brown cotton stalks from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter.

RESULTS OF EXAMINATION

(1) Paper-making trials

The stalks were analysed as a paper-making material with the following results:—

	Per cent.
Moisture	10·2
Cellulose, in stalks as received	44·1
„ in dry stalks	50·1
Ash	2·6

Length of ultimate fibres: 0·5 mm. to 1·0 mm.; average 0·8 mm.

The stalks were treated with caustic soda under conditions similar to those employed in the manufacture of paper on a commercial scale, with the following results, which are expressed on the material as received:—

Experiment	Caustic soda used		Conditions of boiling		Parts of soda consumed per 100 parts of stalks	Yield of dry pulp
	Parts per 100 parts of stalks	Parts per 100 parts of solution	Time Hours	Temperature °C		
						Per cent.
A	16	4	8	160	11·8	41
B	16	4	10	160	13·0	40
C	22	5	9	160	14·6	37 5

These results show that the stalks when treated with 16 per cent. of caustic soda furnished a moderately good yield of pulp, which, however, did not break up completely or bleach very well. The fact that any specimen of paper produced is of somewhat paler colour than the other is probably due to over-beating, as microscopical examination of the first showed the presence of a large number of broken fibres. The pulp in this case would, therefore, be more readily bleached.

By employing 22 per cent. of caustic soda a satisfactory pulp was obtained, which bleached to a pale cream colour and furnished a moderately strong paper of fair quality. The yield of pulp in this trial was, however, rather low.

The stalks were also treated by the sulphite process for 4 hours at a temperature of 140° C and yielded 40 per cent. of dry pulp, expressed on the dry stalks. The material was readily broken up by comparatively mild treatment, but the pulp produced was very dark and could not be satisfactorily bleached; moreover it furnished

a paper of poor strength and quality. These attempts to produce a satisfactory pulp by the sulphite process were not successful, as the treatment, though mild, was found to weaken and partially decompose the wood-fibre of the stalks.

(2) *Dry distillation*

The stalks were also submitted to dry distillation in order to determine the possibility of utilizing them for the production of charcoal, pyroligneous acid and other products. The results, expressed in percentages by weight on the stalks as received, are shown in the following table, which also includes for comparison the corresponding figures recorded for wood :—

—	PRESENT SAMPLE OF COTTON STALKS	'HARD-WOOD'	'WOOD'
		(1)	(2)
Weight of material distilled	3 lbs.	...	...
Time required for distillation	3 hrs. 35 min.	..	...
	Per cent.	*Per cent.*	*Per cent.*
Charcoal	35 4	25 to 27	29
Crude pyroligneous acid containing :—	41 1	45 to 50	42
Acetic acid	3·0	3 to 4	...
Dissolved tar	2·6	3·5	4
Crude wood naphtha (100 per cent.)	1·5	1·5 to 2 (80 per cent.)	1·25
Tar, separated containing :—	7·6	.	6·5
Acetic acid	0·4	...	...
Total yield of tar	10 2	..	10·5
Total yield of acetic acid	3·4	.	3·75

The tar obtained was a fairly thin, readily mobile, liquid of brownish-black colour.

The distillation produced inflammable gases (which were burnt as a supplementary fuel under the retort) and yielded a soft charcoal which broke fairly easily. The charcoal when ground to powder did not compare favourably as regards texture and colour with either lamp black or carbon black, and it would rank only as a fuel charcoal.

The yield of acetic acid is rather below the average quantity obtained from hard woods, but the yield of wood naphtha is about normal.

REMARKS

(1) The foregoing results show that when treated by the caustic soda process these Indian cotton stalks yield paper-pulp of fair quality which can be bleached to a pale cream tint. The yield of pulp is rather low, and it is necessary to employ larger quantities of caustic soda than in the case of esparto and similar grasses, but the results are sufficiently promising to justify further consideration.

In connection with the possible utilization of the stalks for paper-making in India there are several points which need investigation. One of the most important is the cost of collecting the stalks from the fields and conveying them to the factory. On account of the bulky nature of the material it would be essential for the factory to be situated in a locality where large supplies of the stalks are available at a minimum cost for transport, and it would be necessary to have an ample supply of water and facilities for the transport of the pulp to the paper factory. The cost of the necessary fuel and chemicals will also have to be ascertained. In addition it would be advisable to have large scale trials carried out, preferably in India, if this can be arranged, in order to determine the results obtainable on treating the stalks on a commercial scale. Arrangements should therefore be made, if possible, for trials to be conducted at an existing mill, such as that of the Titaghur Paper Mills Company Ltd., at Calcutta.

When this information has been obtained it will be possible to form an opinion as to whether it would be remunerative to use the stalks for paper making in India.

(2) The feasibility of distilling cotton stalks successfully in India will depend upon finding local markets for the products, particularly the charcoal and tar. There is a large demand in the East for acetic acid, and possibly the wood naphtha would find a market in India. The tar could be employed for creosoting purposes and the charcoal as a fuel.

Regarding the cost of distillation, it may be pointed out that as cotton stalks are bulky materials they would require large retorts,

even if they were cut into pieces and compressed before treatment. The cost of fuel will require consideration.

E. A. SCOTT

I.—A system of fire extinction

The growing complexity of Indian life results in a corresponding increase in the number of outbreaks of fire. In the capital cities, and in many of the larger towns, steam fire engines and a fire preventive service are maintained by the local municipal authorities. Beyond the sphere of influence of these fire departments, except in large mills and factories, comparatively little is done to provide protection from outbreaks of fire. Usually, in factories where steam is available, a fire pump and fire mains are provided which can be brought into action at comparatively short notice. Much valuable property in India is, however, entirely unprotected, or only afforded such protection as can be obtained from a few pails of water, a chemical fire extinguisher or a manual pump. Nevertheless, the losses by fire are not serious, and this is largely due to the non-hazardous character of the buildings and their contents. Steadily, however, year by year, the necessity for protection against fire is becoming evident, and the following notes regarding a system of fire extinction which I have lately introduced into the sandalwood oil factories in Bangalore and Mysore may be of some general interest; more especially as, since it has been installed, it has been called into operation on three occasions, each time with perfectly satisfactory results. The preparation of sandalwood for the stills is an extremely hazardous fire risk, and should, as far as possible, be carried on in an entirely separate building. This was not fully recognized when we first built our experimental factories four years ago, and to eliminate as far as possible the risks which have been created it has been necessary to devote much time and attention to the question of providing means for the immediate extinction of fire. The system which is now briefly described was designed by Mr. B. Chatterton, Fire Surveyor of the Yorkshire Insurance Company, and the plant and apparatus were manufactured by Messrs. Francis Polden & Co., 56, Cannon Street, London, E.C. The main idea was to be able to bring a jet of water to bear upon any outbreak

of fire with the least possible delay, and compressed air was chosen as a simple and easily available source of motive power. The compressed air at a pressure of from 100 to 120 pounds per square inch is stored in a cylindrical steel reservoir from which it is carried round the buildings in copper pipes of small diameter. Wherever it is considered desirable to have a supply of water available for fire extinction, a steel cylinder with a capacity of 50 gallons and capable of withstanding a pressure of from 100 to 120 pounds per square inch is installed. These water cylinders are joined up to the air supply by a connecting pipe fitted with a valve. Each water cylinder is supplied with a hose pipe and nozzle connected up for immediate use. On the outbreak of a fire, the stop-cock between the air main and the water vessel is opened and the air pressure on the surface of the water drives it up a central discharge pipe directly connected to the hose and nozzle, making a jet of water with 100 pounds of pressure behind it immediately available. For the charging of the air vessels a small air pump is installed, driven by a 2 horse-power electro-motor; but where electric energy is not available, the air pump can be driven by a hand wheel through suitable gearing. The air cylinder may be of any capacity; but it is conveniently made of the same capacity as the water cylinders. It is very rapidly charged by the electrically driven pump, and it is not very difficult to obtain the required pressure by a hand-driven pump. The fittings should be practically airtight and the loss of pressure almost negligible. The air valve on the air cylinder indicates the pressure inside, and once a day, or at longer intervals, the loss of pressure can be made good by a few strokes of the air pump. The system is not expensive to install, and a very large number of water cylinders can be served from one air reservoir. On the outbreak of fire, one, two or three cylinders may generally be brought into operation, and if three cylinders are used, 150 gallons of water are available: when the cylinders have been emptied there will be four vessels charged with air at 25 pounds pressure. The apparatus is extremely simple, it is not likely to get out of order and it provides a method of fire extinction almost equal to the automatic sprinkler system. Not only does it offer a satisfactory solution of the problem of providing adequate provision against fire for isolated risks where no other kind of protection can be economically installed, but also, on account of the readiness with which it can be brought into action, it is likely to

prove of great value in towns and municipalities in hazardous risks where outbreaks of fire are likely to grow rapidly and to prove difficult to control by the time public fire-extinguishing appliances can be brought to the scene of action.

II.—Industrial Research

In one of the bulletins issued by the Government of Madras in 1906 an account is given of experiments with centrifugal pumps, and attention is drawn to certain defects in their running which rendered them unsuitable when coupled to constant speed motors, such as internal combustion engines. This paper fell into the hands of an engineer, who set to work to design a centrifugal pump to work under variable heads at constant speed. The result was the well-known Rees Roturbo Pump which is now very largely used in the south of India in pumping installations. This example is cited as an illustration of how Indian requirements in regard to mechanical appliances are likely to be met, if it is only clearly made known what is actually wanted.

In recent discussions on the measures necessary to foster industrial development in India, attention has been focussed to a large extent on the supreme importance of providing adequate facilities for chemical research, and the almost equal necessity of a scientific study of the mechanical problems presented by Indian industries and agriculture has been rather lost sight of. In Madras, for instance, the pumping and boring department, in which a good deal of work of this character was done, was transferred to the Agricultural Department and deprived entirely of the advantages arising from association with the engineers of the Department of Industries. As might have been anticipated, the results have been unsatisfactory and it has been found advisable once more to restore pumping and boring to the department with which it was first associated.

What may be termed rural engineering, that is to say, engineering more or less associated with the agricultural requirements of the country, is extraordinarily backward in India, and requires to be studied by competent mechanical engineers with a view to ascertaining the various directions in which it is possible to improve the efficiency of indigenous methods and processes. In Chapter V

of the Report of the Indian Industrial Commission the subject is dealt with under the heading of "Industries and Agriculture," and an attempt is there made to indicate roughly the economic importance of the work which requires to be done. At the first conference of Directors of Industries, held in Simla last year, another phase of the question was put forward in the note on the standardization of machinery and plant with a view to their manufacture in India. The local Governments were subsequently addressed on the question, and it is perhaps noteworthy that only Madras and Bengal expressed general approval of the proposals. In Madras the opinion expressed is the result of practical experience with standardized machinery and plant, and in Bengal there are probably greater facilities for the manufacture of such plant than in any other part of India; and it is doubtless there felt by manufacturers that, instead of stagnation as apprehended elsewhere, standardization will result in rapid development. There seems to be some misunderstanding as to how the standardization will be brought about. It is not a matter for a Committee sitting round a table to deal with, but for experimental work on a very considerable scale by each Department of Industries under the supervision of competent mechanical engineers.

The problem of lifting water in India for the irrigation of land is one of very great importance, and, though it has been the subject of inquiry and experiments for more than 40 years, yet even now it is only partially understood. Up to the outbreak of war experience was rapidly accumulating with regard to the best methods of dealing with the varying conditions which are met with in practice; but gradually, perforce, such work had to cease, and no attempt has yet been made to take it up again. We want a motor and pump, either coupled or combined, which should be suitable for installation in all wells capable of yielding about the quantity of water which can be withdrawn from them by a pair of cattle. The water piston pump invented by Mr. Humphrey seems a likely direction in which investigation work may be undertaken. For motive power various fuels are possible; but the most likely line for successful research seems to be in the direction of providing a very small suction gas plant, one capable of developing, say, 3 horse-power with a consumption of not more than 7 or 8 pounds of charcoal per hour. Such a plant is little more than a piece of laboratory apparatus, and it should not be beyond the resources

of the physicists to overcome the difficulties of working successfully on so small a scale.

Attention may be drawn to the enormous waste associated with indigenous methods of manufacturing *gur*. Something has been done to improve matters both in Bombay and in Madras; but much yet requires to be done. The inability of the sugar cultivators to respond to the stimulating effects of the extraordinarily high prices which have prevailed for the last two or three years is due largely to their inability to provide means for dealing with the cane after it is harvested. Crushing cane is a very heavy strain on the cattle, and the number of cattle cannot be augmented except by the comparatively slow process of breeding. Co-operative working and the introduction of mechanical appliances will almost ease these difficulties: but instead of efforts being made to advance along these lines, apparently less work is now being done in this direction than was the case before the outbreak of the war.

It is unnecessary to emphasize the necessity for research with a view to providing a suitable fuel for domestic consumption in India. It is customary to deplore the enormous loss to an agricultural country through the practice of converting animal manure into *bratties*, but no practical steps have been taken to produce a substitute for this convenient, but extremely objectionable, practice. It is unlikely that a coke can be produced from Indian coals which would serve as an adequate substitute; but, undoubtedly, the fuel supply can be improved by the encouragement of village plantations, and possibly by the conversion of the wood into charcoal and the manufacture therefrom of briquettes analogous to the well-known Charbon de Paris.

Nearly twenty years ago the utility of windmills in India was the subject of lengthy investigation, and the conclusion arrived at was favourable to their employment over considerable tracts of India. The cost of power as generated by cattle or derived from mechanical appliances is now more than double what it was in 1902, and it is, therefore, suggested that there is a wide field for the employment of windmills, not necessarily windmills of the light American type, for irrigation work. It should be remembered that the wind velocity is usually greatest in the hot, dry weather when water for irrigation is most needed. This fact greatly increases the sphere of utility of windmills.

These are some of the most obvious lines of mechanical research. To nearly every one engaged in industrial development others will of necessity suggest themselves.

III.—The manufacture of white lead

In 1917 the Indian Munitions Board drew the attention of chemists in India to the short supply of white lead then coming forward, and suggested that, in view of the large output of lead in Burma, it was desirable to initiate experiments with a view to establishing the industry in this country. Accordingly, experiments were started by Dr. Sudborough and Dr. Watson in the Indian Institute of Science, and, after trials of various methods of manufacture, a wet process was devised which yielded sufficiently good results to justify working on a semi-commercial scale. After some considerable delay a syndicate was formed which supplied sufficient funds to give the process a practical trial. Sanction was accorded by the Council of the Indian Institute of Science for carrying on the work at Hebbal, and during the last two years a considerable quantity of white lead has been manufactured and placed on the market. As already mentioned, the process is a wet one, and all the objectionable features attendant on handling white lead in a dry condition are absent. There have been no cases of lead poisoning amongst the employees, and the conclusion has been arrived at that this method of preparing white lead is one suited to the conditions under which such work should be carried on in this country.

Further developments have been postponed for the present owing to the instability of both exchange and prices. Competition in regard to such a product as white lead is extremely keen, and it will be unwise to establish large works in India at the present moment whilst the cost of machinery is still high and the exchange value of the rupee very low.

A. CHATTERTON

Industrial Alcohol

The possibility of producing industrial alcohol on a scale cheap enough to allow it to be used as a motor fuel has received considerable

attention for some time past. Under a Resolution, No. 5441, dated the 20th August 1920, the Government of India, in the Commerce Department, appointed a small committee, under the presidency of the Hon'ble Sir John Maynard, K.C.I.E., C.S.I., I.C.S., Financial Commissioner, Punjab, with the object of examining the various provincial excise restrictions to see whether they were in any way an obstacle to the manufacture of industrial alcohol on a large scale and, if so, to suggest amendments in them.

The report submitted by the Committee has been published and is now under the consideration of the Government of India. The Committee have summarized in their report the features of the present provincial excise regulations which are the most important from the point of view of their enquiry. Their opinion is that, while the existing regulations offer adequate facilities for the use of industrial alcohol on its present scale, if it is to be used in large quantities, power alcohol should be released from the existing excise restrictions after issue from the distillery. A new denaturant would, however, be necessary in order to render such release safe. Recommendations regarding such a denaturant have been made by the Committee with a proposal that they should be put to the test of experiments. Restriction on production will continue to be necessary. The Committee have recommended that power alcohol, when its definition has been satisfactorily settled, should, after exemption from excise restrictions, be brought under the scope of the Petroleum Act. They have also discussed the regulations to be applied to the transport of power alcohol in bulk, and certain modifications in the various provincial rules regarding other forms of industrial alcohol. They expressed no opinion on the subject of the sources from which power alcohol might be made available, or on the possibility of its production at a sufficiently low cost to enable it to compete with other fuels, these questions being outside the scope of the reference made to them.

Research Associations

The following is a list of Research Associations which have been approved by the Department of Scientific and Industrial Research, London, as complying with the conditions laid down in the Government scheme for the encouragement of industrial research and have

received licences from the Board of Trade under Section 20 of the Companies' (Consolidation) Act of 1908.

1. The British Boot, Shoe and Allied Trades Research Association, Technical School, Abington Square, Northampton.
Secretary—Mr. John Blakeman, M.A., M.Sc.

2. The British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester.
Secretary—Miss B. Thomas.

3. The British Empire Sugar Research Association, 3-5 Old Queen Street, S. W. 1.
Acting Honorary Secretary—Mr. H. T. Pooley.

4. The British Iron Manufacturers' Research Association, Atlantic Chambers, Brazennose Street, Manchester.
Secretary—Mr. H. S. Knowles.

5. The Research Association of British Motor and Allied Manufacturers, 15 Bolton Road, Chiswick, London, W.4.
Director of Research—Mr. H. S. Rowell, O.B.E., A.R.C.Sc. Wh. SCH.

6. The British Photographic Research Association, Sicilian House, Southampton Row, London, W.C. 1.
Secretary—Mr. Arthur C. Brookes.

7. The British Portland Cement Research Association, 6 Lloyd's Avenue, London, E.C. 3.
Secretary—Mr. S. G. S. Panisset, A.C.G.I., F.C.S.

8. The British Research Association for the Woollen and Worsted Industries, "Torridon," Headingley Lane, Leeds.
Secretary—Mr. Arnold Frobisher, B.Sc.

9. The British Scientific Instrument Research Association, 26 Russell Square, W.C. 1.
Secretary—Mr. J. W. Williamson, B. Sc.

10. The Research Association of British Rubber and Tyre Manufacturers, C/o Messrs. W. B. Peat & Co., 11 Ironmonger Lane, E.C. 2.

11. The Linen Industry Research Association, "Glenmore House," Lambeg, Belfast.
Secretary—Miss M. Burton.

12. The Glass Research Association, 50 Bedford Square, W.C. 2.
Secretary—Mr. E. Quine, B.Sc.

13. The British Association of Research for Cocoa, Chocolate, Sugar Confectionery, and Jam Trades, 9 Queen Street Place, E.C. 4.

Secretary—Mr. R. M. Leonard.

14. The British Non-Ferrous Metals Research Association, Athenæum Chambers, 71 Temple Row, Birmingham.

Secretary—Mr. E. A. Smith, A.R.S.M., M.Inst.M.M.

15. The British Refractories Research Association, 14 Great George Street, S.W. 1.

Secretary—Mr. R. C. Rann.

16. The Scottish Shale Oil Scientific and Industrial Research Association, 135 Buchanan Street, Glasgow.

Secretary—Mr. H. R. J. Conacher.

17. The British Leather Trades Research Association, 26 Thomas Street, S.E. 1.

Secretary—Miss M. A. Stevens.

18. The British Launderers' Research Association, 162-7 Bank Chambers, 329 High Holborn, W.C. 2.

Secretary—Mr. J. J. Stark.

19. The British Electrical and Allied Industries Research Association, 19 Tothill Street, Westminster, S.W. 1.

Director of Research—Mr. E. B. Wedmore.

20. The British Silk Research Association, The Silk Association of Great Britain and Ireland, Incorporated, Kingsway House, W.C.

Secretary—Mr. A. B. Ball.

21. The British Motor Cycle and Cycle Car Research Association, "The Towers," Warwick Road, Coventry.

General Manager—Mr. H. R. Watling.

22. The British Cutlery Research Association, P. O., Box 49, Sheffield.

Secretary—Mr. J. M. Denton.

23. The British Music Industries Research Association, Northern Polytechnic Institute, Holloway, No. 7.

Director of Research—Dr. R. S. Clay

Schemes for the establishment of Research Associations in the following industries have reached an advanced state of development.

Research Associations approved by the Department but not yet licensed by the Board of Trade.

The British Jute Industry Research Association.

The British Cast Iron Research Association.

Proposed research associations whose memorandum and articles of association are under consideration.

The British Aircraft Research Association.

The British Research Association for Liquid Fuels for Oil Engines.

In addition to the industries included above, certain others are engaged in the preliminary consideration of schemes for forming Research Associations.

Government purchase of stores

The statement shown below was compiled in response to a question asked recently in the Legislative Assembly regarding the kind, quantity and cost of stores purchased in India by Government during the three official years ending 1919-20. In this statement stores purchased have been classified under the headings of I. Imported stores purchased in India and II. Stores produced in India. The second heading is again subdivided into (*a*) Goods obtained from Government factories, and (*b*) Goods obtained from private dealers. The value of the stores purchased is given throughout in thousands of rupees. The following classes of purchases are excluded from the statement:—

(*i*) Purchases of an aggregate value not exceeding Rs. 50, made at one time and place, of articles of the same kind.

(*ii*) Purchases made by one department of Government from another.

(*iii*) Purchases made by contractors for Government works.

(*iv*) Purchases invariably made in India; *e.g.*, of bricks, Indian lime and mortar, Indian timber, etc.

(*v*) Purchases made by or on behalf of the military authorities, the collection of such figures having been discontinued during the war.

The figures are taken from the abstract returns of expenditure on stores purchased in India which are furnished annually to the Secretary of State. They are compiled from returns made by various purchasing authorities, and the underlying factors are not the same in all cases. They should not, therefore, be taken as an

absolutely complete and accurate account of expenditure, but they present a convenient view of the relative value of imported stores purchased in India and of those produced in the country. Bearing this in mind, the illustration which the figures afford will, it is believed, be instructive to those interested in the development of Indian industries and the improvement of the balance of trade in favour of India. It is hoped that this movement may be given a further impetus by the proposals for the institution of an Indian Stores Department and consequential alterations in the Stores Purchase Rules which have recently been placed before Provincial Governments.

COMPARATIVE STATEMENT SHEWING THE CLASSES OF STORES PURCHASED IN INDIA BY GOVERNMENT DURING THE THREE OFFICIAL YEARS ENDING 1919-20 WITH THEIR VALUE *in thousands of rupees*

1	2			3			4		
Classes, heads and sub-heads	Value of imported stores purchased in India			Value of stores produced in India					
				Cost of goods obtained from Government factories			Cost of goods obtained from private dealers		
	1917-18	1918-19	1919-20	1917-18	1918-19	1919-20	1917-18	1918-19	1919-20
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
A. Bridge work	1,85	52	77	..	..	..	13	29	23
B. Engineers' plant excluding petty tools	3,64	3,12	5,75	4	..	3	49	90	46
C. Workshop machinery and heavy tools	4,52	7,63	7,57	1	4	2	51	66	44
D. Ballast and permanent-way	9	4	1,56	..	..	..	6,48	53,75	35,68
E. Rolling stock—									
(a) Locomotives—									
1. Engines and spare parts	1,86	3,32	2,60	91	..	..	18	46	44
2. Vacuum automatic brake gear and rigging	32	59	51	..	..	..	1	3	27
(b) Coaching and goods stock—									
1. Complete vehicles	31	41	29	1	..	16	22,80	47,36	50,56
2. Iron-work	38	17	68	51	2	9	1,98	1,05	1,07

COMPARATIVE STATEMENT SHEWING THE CLASSES OF STORES PURCHASED IN INDIA BY GOVERNMENT DURING THE THREE OFFICIAL YEARS ENDING 1919-20 WITH THEIR VALUE *in thousands of rupees—contd.*

1	2			3			4		
CLASSES, HEADS AND SUB-HEADS	VALUE OF IMPORTED STORES PURCHASED IN INDIA			VALUE OF STORES PRODUCED IN INDIA					
				COST OF GOODS OBTAINED FROM GOVERNMENT FACTORIES			COST OF GOODS OBTAINED FROM PRIVATE DEALERS		
	1917-18	1918-19	1919-20	1917-18	1918-19	1919-20	1917-18	1918-19	1919-20
	Rs.	Rs.	Rs	Rs.	Rs	Rs.	Rs.	Rs.	Rs.
(b) Coaching and goods stock—*contd.*									
3. Vacuum automatic brake gear and rigging	1,75	3,99	6,05	.	..	..	1	59	1,59
4. Metallic and other fittings	74	1,00	96	..	..	..	12	17	30
5. India-rubber fittings	45	39	14	.	..	..	..	..	3
6. Trimmings . .	37	38	21	..	..	..	3	2	2
(c) Motor-cars . .	91	1,65	4,54	..	.	..	2	9	4
F. Building and station materials and fencing not specifically provided for under G	13,39	8,69	12,44	8	12	32	6,17	7,62	9,44
G. Tools and stores—									
(a) Tools and cutlery .	5,15	8,14	5,94	5	5	4	1,42	2,11	1,78

(5) Stores—									
1. Hardware	10,46	11,97	14,09	16	13	16	4,15	3,47	5,09
2. Lamps and lampware other than glass parts	2,16	2,62	1,95	..	..	..	46	1,52	1,44
3. Wire	2,99	7,38	2,21	..	..	..	7	19	12
4. Metals, unmanufactured—									
Antimony	..	23	12	..	..	..	..	..	..
Brass	71	52	53	1	..	1	27	30	24
Copper	3,90	1,68	6,21	1	16	30	5	45	4
Iron	9,02	9,48	15,44	5	7	3	5,04	12,26	10,52
Lead	36	85	1,32	..	..	2	23	28	8
Steel	19,34	10,47	7,41	..	..	27	5,90	5,02	6,15
Tin	1,97	2,75	4,40	..	4	..	61	78	1,49
Zinc	19	38	79	..	..	1	43	2	2
Miscellaneous	91	97	2,14	3	11	46	32	36	67
5. Timber other than indigenous	54	1,80	2,13	4	..	..	44	..	..
6. Hides and skins	19	7	15	1	..	..	55	62	95
7. Leather and manufactures of leather	87	58	1,12	1,09	93	52	4,41	4,91	4,85
8. India-rubber goods	1,06	93	89	..	..	..	11	28	19
9. Paints and colours	4,95	4,47	5,90	1	..	2	3,35	3,74	4,57
10. Oils	17,24	41,32	43,75	22	25	16	17,29	26,11	25,94
11. Furniture	73	76	78	31	23	35	3,27	4,82	5,87
12. Canvas	2,67	2,72	2,22	30	37	52	1,24	1,40	3,11
13. Cotton goods	5,82	5,09	6,85	2,19	6,57	5,24	21,51	29,96	28,42

COMPARATIVE STATEMENT SHEWING THE CLASSES OF STORES PURCHASED IN INDIA BY GOVERNMENT DURING THE THREE OFFICIAL YEARS ENDING 1919-20 WITH THEIR VALUE *in thousands of rupees—contd.*

1	2			3			4		
CLASSES, HEADS AND SUB-HEADS	VALUE OF IMPORTED STORES PURCHASED IN INDIA			VALUE OF STORES PRODUCED IN INDIA — COST OF GOODS OBTAINED FROM GOVERNMENT FACTORIES			VALUE OF STORES PRODUCED IN INDIA — COST OF GOODS OBTAINED FROM PRIVATE DEALERS		
	1917-18	1918-19	1919-20	1917-18	1918-19	1919-20	1917-18	1918-19	1919-20
	Rs.	Rs	Rs	Rs.	Rs	Rs.	Rs.	Rs	Rs.
(b) Coaching and goods stock—*contd.*									
3 Vacuum automatic brake gear and rigging	1,75	3,99	6,05			.	1	59	1,59
4. Metallic and other fittings	74	1 00	96	.		..	12	17	30
5 India-rubber fittings	45	39	14		..	..	..	..	3
6. Trimmings . .	37	38	21		..	..	3	2	2
(c) Motor-cars . .	91	1 65	4,54			..	2	9	4
F. Building and station materials and fencing not specifically provided for under G	13,39	8,69	12,44	8	12	32	6,17	7,62	9,44
G. Tools and stores—									
(a) Tools and cutlery .	5.15	8,14	5,94	5	5	4	1,42	2,11	1,78

(b) Stores—										
1. Hardware . .	10,46	11,97	14,09	16	13	16	4,15	3,47	5,09
2. Lamps and lampware other than glass parts	2,16	2,62	1,95	..	..	..	46	1,52	1,44
3. Wire . . .	2,99	7,38	2,21	..	..	..	7	19	12
4. Metals, unmanufactured—									
Antimony .	..	23	12	..	..	..	..	..	..
Brass . .	71	52	53	1	..	1	27	30	24
Copper . .	3,90	1,68	6,21	1	16	30	5	45	4
Iron . .	9,02	9,48	15,44	5	7	3	5,04	12,26	10,52
Lead . .	36	85	1,32	..	..	2	23	28	8
Steel . .	19,34	10,47	7,41	..	..	27	5,90	5,02	6,15
Tin . .	1,97	2,75	4,40	..	4	..	61	78	1,49
Zinc . .	19	38	79	..	..	1	43	2	2
Miscellaneous	91	97	2,14	3	11	46	32	36	67
5. Timber other than indigenous	54	1,80	2,1?	4	..	..	44	..	..
6. Hides and skins .	19	7	15	1	..	..	55	62	95
7. Leather and manufactures of leather	87	58	1,12	1,09	93	52	4,41	4,91	4,85
8. India-rubber goods	1,06	93	89	..	..	..	11	28	19
9. Paints and colours	4,95	4,47	5,90	1	..	2	3,35	3,74	4,57
10. Oils . . .	17,24	41,32	43,75	22	25	16	17,29	26,11	25,94
11. Furniture . .	73	76	78	31	23	35	3,27	4,82	5,87
12. Canvas . .	2,67	2,72	2,22	30	37	52	1,24	1,40	3,11
13. Cotton goods .	5,82	5,09	6,85	2,19	6,57	5,24	21,51	29,96	26,42

COMPARATIVE STATEMENT SHEWING THE CLASSES OF STORES PURCHASED IN INDIA BY GOVERNMENT DURING THE THREE OFFICIAL YEARS ENDING 1919-20 WITH THEIR VALUE *in thousands of rupees—concld.*

1	2			3			4		
Classes, heads and sub-heads	Value of imported stores purchased in India			Value of stores produced in India					
				Cost of goods obtained from Government factories			Cost of goods obtained from private dealers		
	1917 18	1918 19	1919 20	1917-18	1918-19	1919-20	1917-18	1918-19	1919-20
	Rs	Rs.	Rs	Rs	Rs	Rs	Rs.	Rs.	Rs.
(b) Stores—contd									
14 Linen goods .	36	19	54	2	6	15	58	93	90
15 Silk goods	2	4	20	2			48	9	19
16 Woollen goods	1,95	1 48	2,76	98	2,00	1,35	9,83	9,49	8,45
17 Miscellaneous apparel and equipment (including jewellery and arms) not provided for under G (b) (7) or (12) to (16)	1,67	1,49	2,28	9	15	17	2,12	1,82	2,09
18. Cordage and rope .	61	66	1,08	9	12	8	1,71	2,19	2,18
19 Chemicals, drugs and medicines	5,37	5,99	5,59	2,68	3,31	3,44	1,26	1,56	1,33
20 Explosives .	86	1,21	1,47	23	34	38	38	51	67
21. Scientific instruments	4,90	3,34	1,97	3	4	8	68	45	42

22. Paper and paste board	2,62	4,90	3,18	37	28	21	76,79	92,33	1,08,56
23. Stationery (excluding paper and paste-board)	4,85	6,07	6,78	94	1,32	77	3,79	5,30	6,31
24. Printing and lithographic materials	1,28	96	74	22	8	20	4,15	1,11	1,12
25. Earthenware, glass and glassware	1,85	2,09	2,26	..	..	12	76	1,85	1,56
26. Pitch and tar .	55	57	45	..	.	1	55	73	1,13
27. Coal and coke .	4,42	29	1,19	7	14	75	1,29,20	1,72,96	1,76,82
28. Portland cement .	3,63	2,56	2,84	1	21	23	6,00	5,3 6	4,87
29. Soap . . .	16	18	13	1	1	6	19	20	25
30. Tallow . . .	3	4	4	.	..	..	9	23	25
31. Wax . . .	1	6	2	..	..	..	14	20	23
32. Wines and spirits .	31	32	33	..	..	1	63	98	1,26
33. Miscellaneous .	7,18	9,25	8,33	81	93	1,07	5,43	8,06	9,91
H. Electrical plants and materials—									
(a) Electric plant . .	92	81	1,70	..	..	..	1	1	5
(b) Instruments and apparatus	1,18	77	2,95	1	1	..	14	6	10
(c) Transmission and distribution materials	3,04	3,21	3,52	8	..	..	1	3	2
(d) Electrical lamps, fans, etc.	5,53	6,05	5,08	1	..	..	1	3	2
(e) Bells, batteries, etc.	1,33	2,33	2,72	..	..	..	3	14	4
TOTAL .	1,76,44	2,01,94	2,28,74	12,71	18,09	17,81	3,54,02	5,18,86	5,28,81

REVIEWS AND NOTICES

Industrial Problems and Disputes. BY LORD ASKWITH. 494 PAGES (LONDON: JOHN MURRAY. 21s. NET).

Lord Askwith's book covers a wide field of industrial enquiry. The main subject of the book, as the title indicates, and as might be expected from the author, is Conciliation and Arbitration. The author, however, manages to include in his book much allied matter. The first five chapters, for example, are devoted to the training of youths in industry. These chapters are useful enough in themselves, but might, with advantage, have been incorporated in a book definitely addressed to parents seeking an industrial career for their children. Several other chapters of his book Lord Askwith devotes to discussions on wider issues, such as the relations of capital and labour (regarding which he considers that both employers and labour leaders have signally failed to find a solution) Socialism, Marxism, Syndicalism and Guild Socialism. By far the most important parts of his book are those specifically given to the discussion of actual industrial disputes. He deals *seriatim* with all the leading strikes and lockouts that have happened in England in the last thirty years. His book is thus an authoritative history of labour disputes during that time. He also devotes several chapters and parts of chapters to the discussion of specific Acts: in fact, these chapters are perhaps the most valuable in the whole book. He deals with the Conciliation Act of 1896, with the Trade Disputes Act and the Taff Vale decision, with the Lemieux Act, with Industrial Councils, Labour Exchanges, Trade Boards, Unemployment and the principles of Arbitration and Conciliation. The latter part of the book is taken up almost entirely with an analysis of war conditions and their relation to labour. These chapters are more of transient than of permanent interest. They deal with temporary expedients to meet temporary exigencies. They have value more as history than as a scientific analysis of the permanent relations of capital and labour.

Lord Askwith has written a book which is both interesting and valuable, and most readers will probably wish that he had gone further and given to the world a standard scientific book on industrial

peace. A fuller account of his own methods and experiences would not only interest, but would act as a useful guide for those whose lot it is to solve the questions which the ever increasing number of strikes and lockouts raise.

(1) *International Labour Legislation.* By H. J. W. Hetherington. 194 pages (London: Methuen. 6s. net).

(2) *Labour as an International Problem.* Edited by E. John Solano. 345 pages (London: Macmillan. 18s. net).

Both these books deal with the recent developments in international labour organization. Principal Hetherington's book is an exposition of the existing International Labour Organization interspersed with his own critical and historical observations. His first chapter deals shortly with the general problem of International Labour Legislation. He proceeds to give an outline of the organization of the International Labour Conference and its executive authority, the International Labour Office. The book is clearly and pleasantly written; the issues are succinctly stated; the critical comments are illuminating.

In "Labour as an International Problem" Mr. Solano has collected a series of essays, by various writers, on international labour organization and industrial problems generally. Mr. Barnes writes on "The Scope and Purpose of International Labour Legislation." Professor Shotwell deals with the "Historical Significance of the International Labour Conference." Mr. W. A. Appleton writes a chapter on "International Trade Unionism," in which he gives a useful statement of the aims of the "Trade Union International." Mr. Minoru Oka deals with "Labour Legislation in Japan," a chapter which is particularly interesting for the purposes of a comparative study of Japanese and Indian industrial conditions. M. Emile Vandervelde deals with "Labour Reforms in Belgium." The practical questions which were dealt with at the International Labour Conference are discussed by Miss Sophy Sanger. M. Fontaine gives "A Review of International Labour Legislation," and Mr. Butler, the Secretary General of the Washington Conference, writes on "The Washington Conference." The Director of the International Labour Office, M. Thomas, writes a chapter on

"The Task of the International Labour Office." Each article is short and to the point, and the book forms an excellent introduction to the study of international labour legislation, although, as Mr. Solano points out, events have moved quickly (*e.g.*, in Japan and India) since the articles were written.

Each book contains numerous appendices—The Labour Sections (Part XIII) of the Treaty of Versailles, The Conventions and Recommendations of the Washington Conference, and the Members and the Governing Body of the International Labour Office. The volume edited by Mr. Solano also contains the Conventions and Recommendations of the Genoa Conference.

Industrial Administration. BY VARIOUS AUTHORS. 203 PAGES. (MANCHESTER UNIVERSITY PRESS. 7*s*. 6*d*.)

This volume contains eight lectures delivered in the College of Technology, Manchester, in the Session 1918-19. Three of the lectures deal with education and industry. Professor Pear writes on "The Applications of Psychology to Industry," in which he lays down certain guiding principles for the use of teachers. In "Education as a Function of Management" Mr. A. E. Berriman, the Chief Engineer of the Daimler Works, Coventry, deals with the training of apprentices. Mr. St. George Heath, in a paper on "Training for Factory Administration," writes on the more advanced training necessary in the management of a modern factory. Three of the lectures deal with medical and physiological problems. Dr. T. M. Legge, Medical Inspector of Factories in England, gives a very interesting paper on "Occupational Diseases." Dr. Leonard Hill deals with "Atmospheric Conditions and Efficiency"; and Dr. Stanley Kent writes on "Industrial Fatigue." These three papers are very useful studies in departments of enquiry which are in their infancy in India. The remaining two papers deal with more general problems. Mr. Seebohm Rowntree writes on the "Social Obligations of Industry to Labour," in which, amongst other things, he deals with the family-budget minimum wage. Mr. T. B. Johnston, one of the pioneers of Industrial Councils, contributes a very interesting paper on "Industrial Councils and their Possibilities," a paper in which he gives the constitution of the first National Council in the pottery industry.

Labour and Industry. BY VARIOUS AUTHORS. 294 PAGES (MANCHESTER UNIVERSITY PRESS. 8*s*. 6*d*.)

This book is a series of lectures delivered in the Department of Industrial Administration in the School of Technology, Manchester, during the 1919-20 session. In all there are twelve lectures. Each lecture is by a recognized authority on the subject with which it deals. The lectures fall into two main groups. The first group includes some six lectures dealing with the main problems of industrial organization and control. The others are lectures on certain specialized subjects connected with industrial organization. The opening lecture is by Mr. J. H. Whitley, who discusses the Council associated with his name. Mr. Whitley's paper is an interesting commentary on the now well-known four Reports. Other papers that deal with similar subjects are "Democracy in Industry" by Mr. G. D. H. Cole; "Recent Thoughts on the Government of Industry" by Mr. R. H. Tawney; "Organized Labour in Relation to Industrial Development" by Mr. J. R. Clynes; and "Industrial Unrest—Some Causes and Remedies" by Professor J. B. Baillie. These papers, individually and collectively, afford a good representation of current enlightened opinion towards labour. The other papers deal with individual problems of labour. In his paper on "Unemployment" Mr. Percy Alden gives a resumé of the theory and practice of unemployment—a useful historical and analytical account of the problem. In her "The Human Element in Industry" Miss Voysey, the General Secretary of the Welfare Workers Institute, gives an account of the scope and organization of welfare work. In his paper on "Labour and Continued Education," Mr. F. W. Goldstone deals with the problem of the continuation school in its various aspects. Mr. Bellhouse, the Deputy Chief Inspector of Factories in England, writes a very interesting paper on "Accident Prevention and Safety First." Mr. Bellhouse advocates the institution in England of the American system of safety organizations. Sir Malcolm Delevingne deals with "International Regulation of Labour under the Peace Treaty." His paper is a short and first-hand account of the labour aspects and results of the Peace Treaty. In his paper "Finance and Industry" Sir Drummond Fraser argues that Government should borrow directly from the people by a simple form of short-dated bond as against the ordinary method of "a spectacular long-dated loan." In "Labour—Its Output and

Reward" Mr. Pybus gives a summary analysis of the arguments for and against time- and piece-work wages.

PROVINCIAL REPORTS

The report of the Department of Industries, Bombay, by Mr. G. H. Thiselton-Dyer contains a number of interesting features. The Chemical branch appears to have been particularly active and their investigations have included such subjects as casein, hide—pickers, oil analysis, hand-made paper and bitterns. The results so far obtained in the inquiries regarding casein and bitterns have already been published in bulletins.

Interesting developments are taking place in connection with fisheries. Mr. T. J. Walke has been experimenting with sardines for the purpose of obtaining oil and guano He has succeeded in producing an oil which may prove an effective substitute for cod-liver oil. The guano produced has also been favourably reported on. Fish smoking has been the subject of successful experiments and it is intended to obtain an experimental trawler from England. The trawler will be equipped with refrigerating plant so that it will be able to remain at sea for several days and still bring fish to harbour in a fresh state.

The question of the development of the power potentialities of the province is also discussed. The Director of Industries points out that the extraction of industrial alcohol from *mahua* on a large scale is not a paying proposition. He suggests that the use of suction gas producers, working simple gas engines, may prove to be one solution of the problem for the small producer.

The report contains attractive items on several other subjects, such as pottery, dyes, sugar, calico printing, hand-loom weaving and technical education It is satisfactory to note the growing desire of boys who would otherwise have entered on a clerical career to become workshop apprentices

The report is in a handy form – an example that might well be copied elswhere—and can be obtained for five annas from the Government Book Depôt, Poona.

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To the Madras Government belongs the credit of having been foremost in advocating State development of industries in India, and

it is appropriate that the Report of the Department of Industries for the year which saw the inauguration of a new policy should contain a survey of the efforts made to secure the adherence of the Secretary of State to the policy now approved.

In 1905 the Madras Government submitted a scheme for the creation of a Department which was intended to initiate experiments which might assist private enterprise to take up fresh industrial undertakings. Lord Morley was sceptical regarding the possibility of stimulating industries by State efforts, but he sanctioned the creation of a new Department in 1906, and Mr. (afterwards Sir Alfred) Chatterton was appointed to the charge of it as Director of Industrial and Technical Enquiries. In 1908 an Industrial Conference at Ootacamund strongly advocated a forward policy, and in March 1909 proposals were made to the Secretary of State by Government for the creation of a permanent Department of Industries which would have charge of industrial education and which, in addition to maintaining an industrial intelligence bureau, would be empowered to introduce new industries with a view to encouraging trade. In October 1908 the Department of Industries had been actually created in anticipation of sanction. But in 1910 Lord Morley in a second despatch condemned the policy of attempting to create new industries by State intervention, and stated his disapproval of any State enterprise which had the semblance of a commercial venture. As a result of his orders the Madras Department of Industries was abolished.

Lord Morley's orders aroused considerable opposition and, following a resolution in the Legislative Council of Madras, the Secretary of State was again approached and was asked to reconsider his decision. Lord Crewe's reply in March 1912 modified the policy in certain directions and made it possible for the Madras Government to re-create the Department of Industries in 1914; but the functions of the Director of Industries were strictly limited. The report of the Indian Industrial Commission of 1918 strongly recommended a complete change of policy. Their proposals depended on the acceptance of two principles :—

(1) That in future Government must play an active part in the industrial development of the country with the aim of making India more self-contained in respect of men and material.

(2) That it is impossible for Government to undertake that part unless provided with adequate administrative equipment forearmed with reliable scientific and technical advice.

These fundamental principles have now been accepted by the Secretary of State.

The rest of the report of the Director of Industries, Madras, for the year 1919-20 is a striking commentary on the results achieved by the new policy which has resulted in a great move forward in the industrial development of the Presidency.

We commend the report on Technical and Industrial Education in the United Provinces for 1919-20 to all who are interested in this subject. At the present time there is a distinct shortage of trained apprentices, and, all over India, those who have received a sound technical education have no difficulty in finding lucrative employment. Indeed, the keen competition for trained artisans acts as a temptation to boys to stop their education before it is complete, *e.g.*, in the School of Arts and Crafts at Lucknow the Director of Industries notes that there are frequent cases of boys leaving the school to take up work before the completion of the course, and it is not surprising to learn that, so far as is known, no past pupil of this school is out of work. An interesting schedule shows the rates of pay now being drawn by students who have left the Government Technical School at Lucknow during the last five years. The average is over Rs. 60 a month, and about a quarter of the students are already drawing Rs. 100 or over. About 300 boys are on the rolls of the three technical schools. The School of Arts and Crafts, Lucknow, has over 100, the Carpentry School at Allahabad has 72, and the Central Weaving Institute, Benares, 121. There are large numbers in the fixed and mobile weaving schools, and the Leather and Dyeing and Printing Schools at Cawnpore are vigorous. Useful work is also being done by a number of aided schools. Thus the Y. M. C. A. Industrial School of Allahabad and the Lucknow Christian School of Commerce, both of which give a sound commercial training, have each about 200 students. Altogether there is good reason to believe that in the United Provinces, as elsewhere, Indian boys and their parents are realizing the great possibilities of industrial and business careers.

Publications of the Geological Survey of India

During the quarter January 1st to April 1st, 1921, the following publications were issued by the Geological Survey of India—Records, Vol. LI, part 2, including the following papers:—

(*I*) *Classification of the Recent and fossil Cypræidæ*, by E. Vredenburg. Palæontologists, zoologists and botanists have for some time felt that a much more intimate and mutual co-operation was desirable in the study of any particular group of the animal and vegetable kingdoms. The stereotyped practice in the past has been for the palæontologist to confine his attention entirely to fossil forms, while the zoologist or botanist on his side has restricted his observations to living forms. A combined study of extinct and living types in the case of some of the vertebrate groups proved of such inestimable value to both sides of the enquiry that it has been extended with beneficial results to invertebrate animal groups. Mr. Vredenburg's paper presents a scheme of classification of that family of prosobranchiate gastropods known as the *Cypræidæ*, based on a study of both fossil and living forms.

(*II*) *Sulphur near the confluence of the Greater Zab with the Tigris, Mesopotamia*, by E. H. Pascoe. The author describes a natural emanation on a large scale of sulphuretted hydrogen from a relict channel of the Tigris River, some twenty-four miles below Mosul. The evolution of this poisonous gas is so brisk as to make it dangerous to approach the spot. The occurrence is worthy of the attention of a sulphuric acid expert, as the gas is easily converted into sulphuric acid and the supply thereof appears to be continuous and considerable.

(*III & IV*) Two notes by H. C. Jones, one on the occurrence of Monazite in a stream near the village of Wan-Hapalam in the Southern Shan States and another on an occurrence of graptolites in the same country. The latter would appear to be a continuation of the band of Llandovery age found by Mr. La Touche in the Northern Shan States.

(*V*) A note on the growth of an efflorescence of Cerium sulphate on Travancore Graphite, by M. Stuart.

Records, Volume LI, Part 3, including the following papers:—

(*1*) *The Mineral Production of India during 1919.* BY E. H. PASCOE.

In drawing comparisons between the values of the outputs of the various minerals for the two years 1918 and 1919, the official exchange figures of 1*s*. 4*d*. and 2*s*. have been employed respectively. These values for the rupee are considerably wide of the average values for each of the two years—1*s*. $5\frac{11}{16}d$ for 1918 and 1*s*. $8\frac{27}{32}d$. for 1919—but it is impossible to give accurate figures without knowing the size of every parcel sold and the date on which it was sold. Anyone preferring to adopt the average sterling exchange value of the rupee for each year can multiply the sterling values by the factor 1·10505 in the case of 1918, and by the factor ·8685 in the case of 1919. The more outstanding features of the report are an increase of about 2 million tons in the output of coal—due chiefly to Bengal and Bihar and Orissa—the recovery of the copper industry of Singhbhum, a steady increase in the output of iron-ore, a similar increase in that of lead and silver from Bawdwin, and an increase of about 19 million gallons in the output of petroleum with, at the same time, an increase of over 300 per cent. in the imports of kerosene oil; the output of tin was nearly doubled while that of wolfram declined substantially. 602 prospecting licenses and 106 mining leases were granted during 1919.

(*2*) *Results of a revision of some portions of Dr. Noetling's Second Monograph on the Tertiary Fauna of Burma. (With one text figure).* BY E. VREDENBURG.

This paper is a much needed and creditable attempt to rectify the bewildering confusion in the nomenclature of the divisions and the schemes of classification concerning the post-Eocene rocks of Burma. The author finds that Dr. Noetling's classification of these rocks into the groups—

	3 Irrawadi series	
Pegu .	2 Yenangyoungian	
	1 Promeian . . .	Prome Sandstone Sitsayan shales

is so far from being correct that the fauna of the Yenangyoungian includes forms belonging to the Sitsayan shales horizon as well as forms which are so new as to suggest the lowermost horizons of

the Irrawadi series. In other words, the fauna of Dr. Noetling's Yenangyoungian stage embraces the entire Pegu series. The author points out, what Dr. Pascoe had already called attention to, that the boundary line between a lower petroliferous and an upper non-petroliferous group in the oilfields is a purely artificial one, depending on the depth to which an anticline had been denuded, the non-petroliferous character of the upper group being due to the exposure of the strata and the consequent escape of any oil. In spite of the unconformity between the Irrawadi and Pegu series, which can be seen in the south of the Yenangyaung anticline, most observers will agree with the writer that "the uppermost exposed zones of the beds underlying the Irrawadi series at Yenangyaung, Singu, and Yenangyat, undoubtedly belong approximately to the same geological horizon." The conclusion arrived at is that the true sequence of the principal faunas described by Noetling in the publications of the Geological Survey of India are in descending order—

4 Kama
3 Singu
2 Minbu
1 Yenangyat

Dr. Noetling's zones are considered one by one, and the paper concludes with a revision of some of the forms figured in his memoir published in the Palæontologia Indica (New Series, Vol. I, No. 3), and a stratigraphical list of the fossils specifically identified.

(3) *Note on the Marine Fossils collected by Mr. Pinfold in the Garo Hills.* (*With 2 plates*). BY E. VREDENBURG.

The fossils described came from two localities, one near the Sumeswari River, 1½ miles south-west of Bagmara village, and the other west of the former, 4 miles north of the town of Dalu. The shells are fragmentary and delicate, indicating a depth of some thirty fathoms, and are accompanied by sharks' teeth and otoliths. The conclusion reached is that the Sumeswari fauna is probably equivalent in age to the upper limit of the Gaj in North-western India and on the same line as the Pyalo stage of the Burma Pegu, just above the Kama stage. The paper concludes with some hypothetical remarks regarding the age of the Tipam Sandstone and the so-called "Coal Measures" of Upper Assam.

Records, Geological Survey of India, Volume LII, 1921. Quinquennial Review of Mineral Production of India for 1914 to 1918

The publication of this review was unfortunately delayed by the strike in the Government Press. The system of collaboration adopted in the last two quinquennial reviews has been expanded in the one under consideration, for which the Director and five senior officers of the Geological Survey of India are responsible. The object of the review is to summarize the progress of each particular mineral industry during five years, a period not too long to disconnect the average figure from the figure for the single year following, and not too short to show any particular phase, any steady increase or decrease in the output, of each mineral. The most remarkable increases occurred in the case of coal, manganese, salt, tin, chromite, saltpetre, tungsten and silver. The increase in value during the period totals over £5,000,000, as compared with a little over £2,000,000 in the preceding five years, but the effect is magnified by the inflated prices of most of the products. The only mineral which shewed a decline of any importance was gold, and this was due to certain mines closing down, a result of the rise in price of all ordinary commodities. The activity and output of the Tata Iron and Steel Works and the Bengal Iron and Steel Company were greatly stimulated during the war, as were also the lead-silver operations of the Burma Corporation. Copper-smelting at the Rakha mines in Singbhum was begun towards the end of 1918.

Memoirs, Geological Survey of India, Vol. XL, Part 3. Petroleum in the Punjab and North-West Frontier Province. (With 20 plates of maps and sections). BY E. H. PASCOE.

The work of which this Memoir is the result was interrupted by illness, military service and minor causes. In it the author develops the idea, brought forward in his memoirs on the Burma oilfields and the petroleum occurrences of Assam and Bengal, that the beds in which the petroleum is now mostly found, and to which there is some reason to suppose it is indigenous, were deposited in a gulf. The gulf in each case became silted up and gave place to a river valley. In the case of Burma this valley was the precursor of the present Irrawadi. The Meghna is all that is left of the river which supplanted the Assam gulf. The Punjab gulf reached as far

as Naini Tal in an eastern direction and extended through Baluchistan to the old Arabian Sea. The river replacing this gulf was of an unusual length and has been named the Indobrahm, since it is thought to have included the middle waters of the Brahmaputra, the middle portion of the Ganges, and the lower half of the Indus. The greater part of a chapter is devoted to the interesting, though somewhat hypothetical, history of this river. Gulfs, of the silting up of which the formation of petroleum is thought by the author to be one of the results, are produced by orogenic folding movements which buckle the earth's crest into complicated ranges of hills, the gulf occupying a corresponding trough or valley in front of such ranges; such a trough or valley has been termed a 'fore-deep' by Prof: E. Suess. The term 'oil-belt' may be applied to each fore-deep or gulf in which oil is subsequently formed, or it may be applied to a more or less continuous line of fore-deeps or gulfs. A series of buckling movements usually causes a continuous or slightly échelonned line of such troughs, and it is for this reason that we can trace an interrupted line or belt of oil occurrences from the Island of Sakhalin, through Japan, Formosa, the Philippine Islands, Borneo, the Celebes and Moluccas, Java, Sumatra, Burma, Assam, the Punjab, Baluchistan, the Makran Coast, South-Western Persia and Mesopotamia. The Turkistan, Caucasus and Carpathian deposits appear to be on a separate belt.

The writer concludes that the most promising country in which to look for oil in North-Western India is that between the Kala Chitta ranges north-west of Rawalpindi and the Salt Range, and that between the Khasor Hills and the Waziristan Hills. It is in these two regions where gently folded anticlines and domes suitable for the retention of oil might be expected. One such dome has already been found to be oil-bearing in the former of the two regions mentioned.

The paper deals at some length with the structure of the Salt Range in which several oil-seepages are known, and the theory favoured is that which was adopted by Sir Thomas Holland, and which makes the Salt Range an overthrust and the salt and petroleum deposits Tertiary, like those on the other side of the Indus; the only modification made is the suggested inclusion of the Purple Sandstone with the Tertiary deposits. Nearly every known oil-locality in this corner of India is described, the gas and doubtful

bituminous occurrences in Jammu, Kangra and Simla are discussed, and the concluding chapters relate to general structure, the geotectonics of the oil belt, vulcanicity, gypsum, rock-salt, sulphur, and the origin and mode of accumulation of petroleum.

Memoirs, Geological Survey of India, Volume XLIV. The Geology of Idar State. (With 17 plates). BY C. S. MIDDLEMISS.

Idar, the chief Rajput State of the Mahi Kantha Agency in the Bombay Presidency, includes the south-western prolongation of the old Aravalli hill-range. Beyond a little unfossiliferous sandstone, the Ahmednagar Sandstone—probably of Jurassic to Cretaceous age—the only rocks exposed in the State are a series of Phyllites and the Delhi Quartzite series, both probably belonging to the Purana group, and gneisses, amphibolites and schists assigned to the Upper Archaean under Hackét's name of the "Aravalli System." The Aravalli beds in the north and west of the State form a complex, the serial position of the members of which is indeterminable. In these circumstances no estimate of the total thickness is possible. These rocks are traversed by numerous veins of Aplite. The Delhi Quartzite characterizes the south-eastern half of the State and gives rise to sharp ridges, it is not found lying upon the Aravallis or any other rocks, and passes up into the Phyllite series. Intrusive granite and quartz-porphyry are seen in the neighbourhood of Idar town.

Idar State contains abundant building materials, including granite, impure marbles, good limestone, clays, sandstone and kankar; the Ahmednagar freestone especially merits attention and is an important asset to the State Large quantities of steatite of variable quality occur, and asbestos of the hornblende variety is found in long, pure, silky, soft, flexible fibres near Dev Mori and Kundol; sticks of the latter mineral about a foot long can be dug up and soften readily on maceration. Small quantities of manganese, serpentine, magnesite, chromite, rose-quartz, and rare earths are also to be found.

A geological map on the scale of 1 inch to 4 miles accompanies the memoir, which is illustrated by sixteen plates of views and microsections.

Second Reprint of Memoirs, Geological Survey of India, Volume VI, Part 2. The Bokaro Coal-field. BY T. W. H. HUGHES. *The Ramgarh Coal-field.* BY V. BALL. *The Traps of Western and Central India. (With one map and one text figure).* BY W. T. BLANFORD.

This volume of the memoirs was published originally in 1867 and a reprint of it appeared in 1908. To meet a continued demand from the public for the two coal memoirs, a second reprint has been thought advisable. Recent work has shewn that Mr. Hughes' views require some modification, especially with regard to the beds of Ironstone Shale mapped by that observer near Gamiya, which have been found to be almost non-existent, but in other respects Mr. Hughes' work has been found sufficiently accurate for the purpose of a small-scale map. Neither the map nor the old form of spelling has been revised, so that the issue must be looked upon as a reprint pure and simple, pending the completion of a more exhaustive survey.

Bibliography of Indian Geology, Part II, Index of Localities. BY T. D. LATOUCHE.

Part II of the Bibliography of Indian Geology and Physical Geography, published by the Geological Survey of India in 1918, contained a summary account of known occurrences of various minerals throughout the Indian Empire. These accounts were grouped under the heading of the respective minerals which were arranged in alphabetical order. The publication under consideration is an index of all the locality names used in the summaries mentioned. The index itself is preceded by a list of districts and States arranged alphabetically. The scheme of the index is the converse of that used in the summary accounts, the name of the particular mineral now being subordinate to the place at which it is found. The name of the locality is now followed by that of any mineral which occurs at or near it. The utility of such an index needs no advertisement; it forms a fitting end to a piece of most laborious and invaluable work which we owe to the capable hands of Mr. LaTouche.

The Editor will be glad to consider original articles for publication in this Journal and will endeavour to return any forwarded to him that are not retained for publication. Correspondence relating to articles in the Journal is also invited. All communications should be addressed to the Editor of Publications, Department of Industries, Simla.

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THE GOVERNMENT ACETONE FACTORY, NASIK ROAD

BY

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The nature of the dangers and difficulties which the British Empire had to face and overcome during the great war have been made known only to a limited extent. The magnitude of her scientific achievements is imperfectly understood. Could the full story be made known, however, it would be a stimulating surprise, not only to scientists but to those who, in these days of peace, are wont to lament the difficulties which modern industry presents.

Many are familiar with the part cordite has played in the war, but few, perhaps, realize that India made a notable contribution to the Empire's supplies of this important explosive. Cordite consists of nitrocellulose and nitroglycerine mixed with a certain amount of mineral jelly, and it was acetone which was used to gelatinize these substances for the production of the various cordites early in the war. Acetone is a colourless, highly inflammable and volatile solvent which is largely recovered for use again in the manufacture of cordite.

Prior to the war acetone was imported from the United States and Austria, where it was obtained from acetate of lime which was

produced by neutralizing with lime the acetic acid resulting from the distillation of wood. It is true that a small quantity of acetone was obtained in England in a similar manner, but insufficient to meet peace time requirements, let alone the almost unlimited demand which obtained in 1915. Steps were taken to increase the sources of our American supply since the quantity of acetone began to set a limit to the output of cordite. In other words, the supply of acetone became the weakest link in the chain of operations for the production of cordite. It became imperative, therefore, not only to forge a new link by attempting to discover a substitute for acetone, but to strengthen the old one. It is the object of this article to describe how the old link has been strengthened and to indicate how, incidentally, a new link has been forged.

For some years prior to 1915 India had felt the necessity for manufacturing her own acetone and becoming independent of supplies from abroad. Early in the war, however, she found herself, so far as her supply of acetone was concerned, in much the same position as the United Kingdom. It was soon made obvious that India must manufacture essential commodities if she was to play an important part in Imperial defence.

A new process for the manufacture of acetone which was being developed by the Admiralty and Ministry of Munitions in England seemed to offer great possibilities in India, particularly since the raw material required was cereals. Owing to the large and increasing demands for acetone in America and the United Kingdom, not only for the manufacture of cordite but also for aeroplane dope, India's requirements could hardly be met. It was therefore decided to adopt the latest scientific developments and to erect a plant suitable for this new process. Before proceeding, however, to describe the new process and plant a brief history of the former may not be out of place.

The synthesis of rubber has been the subject of much scientific investigation. Butadiene had been polymerized to form rubber, but little hope of commercial success was entertained in the absence of cheap butyl alcohol. In 1912, however, Dr. Fernbach of the Pasteur Institute isolated a micro-organism which fermented carbohydrate material and yielded acetone and butyl alcohol. The formation of alcohols by bacterial action had long been recognized, but Fernbach made a notable advance in securing an organism which produced

both butyl alcohol and acetone in relatively large quantities from raw material which existed in abundance. Experiments on a factory scale with Dr. Fernbach's bacilli were being conducted at Kings Lynn with potatoes as the raw material when in 1915 Dr. Charles Weizmann of Manchester University, at the critical juncture referred to above, offered cultures of an acetone-producing micro-organism to the Admiralty. This latter bacillus when inoculated into mash made from maize meal yielded butyl alcohol and acetone in exactly the same way as that of Professor Fernbach.

Dr. Weizmann demonstrated the great commercial possibilities of the cultures of his micro-organism, and his laboratory experiments were so encouraging that the Admiralty and the Ministry of Munitions decided to prosecute further research at the Lister Institute of Preventive Medicine A number of chemists and bacteriologists set to work to produce acetone by this new process on a factory scale.

The production of acetone by means of this organism was found to be a relatively simple matter in the laboratory. It was only when the fermentation was attempted on a large scale that difficulties arose. This is not surprising when it is borne in mind that in the laboratory the factors limiting the rapidity and extent of the fermentation could easily be studied, whereas under factory conditions factors altogether new made their appearance, which it was difficult and in some cases impossible to control.

So great was the need for acetone that use had to be made as far as possible of existing plants. Several distilleries in the United Kingdom were, therefore, taken over, and the Admiralty erected an acetone factory at the Royal Naval Cordite Factory. After a considerable amount of factory experimentation, and when most of the difficulties which the plants existing in the distilleries presented had been overcome, the shortage of raw material unfortunately prohibited further work. The Kings Lynn factory, however, where suitable plant existed, continued operations until the armistice, making use of horse chestnuts as the source of starch, and distilleries both in America and Canada, being more favourably situated for securing raw material, started the manufacture of acetone by this new process, and by making use of the knowledge gained from the

work carried out at the Royal Naval Cordite Factory and elsewhere were able to achieve great success.

This is not the place in which to detail the nature of the obstacles to successful working which were encountered in England. Suffice it to say that, owing to the enthusiasm and whole-hearted devotion of a band of scientific workers, the difficulties were overcome, not so much by the application of scientific data as by the use of scientific sense.

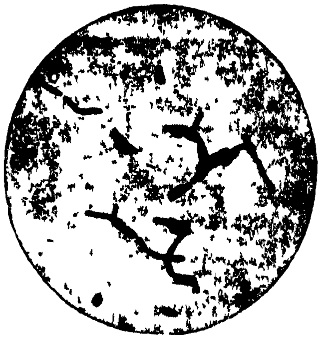
The acetone process

The acetone organism is a minute anærobic bacillus with slightly rounded ends. It is motile and varies considerably in length. The age of a culture and the method of cultivation, amongst other things, influence the size and appearance of the organism. Non-sporeing individuals show wide variation in both length and breadth, but an average size is 3 μ to 4 $\mu \times 1 \mu$. The organism stains readily with carbol fuschin and less readily with methylene blue. Degenerate forms show irregular staining and are frequently curved and vacuolated. Reproduction takes place by transverse fission, and when the conditions under which the bacillus is active become unfavourable spores are formed. Under favourable conditions, however, the spores germinate and give rise again to vegetative cells, but reproduction by this means is secondary to that by simple fission. Spores can be preserved in liquid or on dry sand, and this property enables fresh cultures to be started up from time to time.

The new acetone process consists of the fermentation of starch, sugar or compounds intermediate between the two by the organism described above. A suitable medium for the growth of the acetone organism is obtained by mashing maize, rice, *jowari*, wheat or other carbohydrate material with water and sterilizing the mixture. A concentration of 4 to 7 per cent. of such material in water is boiled to gelatinize the starch and subsequently heated to destroy micro-organisms which the raw material invariably contains. A sterile mash when inoculated with the acetone organism and incubated at blood temperature rapidly ferments with the evolution of carbon dioxide mixed with an almost equal proportion of hydrogen. The liquid gradually clarifies, and after approximately 24 hours, when gas evolution has ceased, acetone and butyl alcohol, roughly in the

proportion of 1 : 2, are found in the liquid and may be removed by distillation.

TYPICAL SCATTERED FIELD



CHAINS

SPORES

MICROPHOTOGRAPHS OF THE ACETONE ORGANISM (x 1,000).

To maintain a culture active, however, the organism is carried over every 24 hours into fresh sterile mash tubes before this final

stage is reached. It is when the liquid is fermenting most vigorously, and before acetone and butyl alcohol have been formed in appreciable quantities, that sub-cultures are made. The culture of the acetone organism is prepared in gradually increasing volumes by inoculating sterile media with vigorous sub-cultures until the final stage, that is the inoculation of the bulk medium of 20,000 gallons in a large fermentation vat, is reached.

Great care is taken to keep the acetone cultures pure for reasons which will be referred to later. They are examined microscopically every day, and their capacity to yield acetone is determined prior to use in the factory. It is customary to inoculate with 80 ccs. of a vigorously fermenting tube culture a two gallon aluminium inoculating pail designed by the writer. Sterile rice or other suitable mash is prepared in the pail, which is provided with an inoculating valve on which a pressure gauge can be fitted. After inoculation the pail is incubated at 37°C, and the gas which is produced is at first allowed to escape freely. Two or three hours before this culture is required for inoculating a seed pot a pressure gauge is screwed on to the pail and the fermentation gas is confined in the space above the liquid. After approximately 24 hours' incubation the pail is ready for use in the factory in much the same way as a syringe. The pail is connected up by means of sterile tubes to an inoculating valve on the seed pots described below and the inoculant is rapidly discharged by means of its own gas pressure into the sterile mash which has previously been prepared. The seed pot inoculated in this way commences to ferment, and after approximately 24 hours is ready to be used for inoculating a large vat of medium.

The writer does not propose to deal with the mechanism of the reactions which take place during the fermentation of the mash. There is one feature of the reactions, however, which is of the greatest importance in connection with the general question of infection and sterilization.

Infection and sterilization

One of the most striking features of this new acetone bacillus is that it cannot withstand competition for food with other starch-decomposing organisms. After inoculation of the mash the acidity gradually rises to a maximum. Up to this point no appreciable quantity of acetone or butyl alcohol is formed. It is only when the acidity begins to fall, that is, after some 24 hours' fermentation, that these products are formed. If infection gets a firm hold before this

initial period has elapsed, that is, before the acidity has begun to fall, the acetone fermentation stops, and no acetone or butyl alcohol is produced. Infection after the acidity of the mash has begun to fall rarely survives, and, in order to shorten the period during which the acidity is rising, a relatively large inoculant is used in the factory. Experience indicates that the types of infection against which it is imperative to guard are those found on the grain itself. Success with this process is measured by the extent to which such infections can be destroyed or suppressed, and it is the nature of the bacterial flora on any particular raw material in relationship to the means available in the factory to destroy such flora which is of prime importance in connection with the successful manufacture of acetone by this process.

Absolute sterility in the laboratory is not difficult to obtain, but it is not possible or essential on a factory scale. Infection forms in the factory are not allowed to develop to such a point as to endanger the life of the acetone organism. Routine methods of attack, such as the steaming of pipe lines, culture vessels, vats and valves, succeed in keeping the enemy in check, but there always remains a residual enemy which, between one sterilization and the next, is continuously strengthening its forces.

The acetone organism is human in this respect that, if properly fed, infections are not so liable to impair its efficiency. Where poor mash is being fermented, the acetone organism is not virulent and does not readily form spores, so that the enemy gets a firmer hold and the residual infection contains a lower proportion of acetone organisms amongst their number. When the sterilizations or attacks on this residual enemy take place, the difference between the numbers killed and the numbers which remain gradually increases, until a point is reached where a fermentation failure is bound to occur. It is before this point is reached that drastic measures have to be taken to throw the enemy back to the point where the routine attacks suffice to render him comparatively harmless. From what has been said, therefore, it will be clear that the mash has to be carefully prepared, and that the carrying out of the acetone process involves continuous warfare against dangerous infecting organisms: in other words, it is only by having the greatest consideration for the well-being of the acetone organism that satisfactory yields of acetone can be obtained.

Products

The yield of acetone and butyl alcohol depends on the starch content of the raw material which is used. For this reason rice gives higher yields than maize potatoes or horse chestnuts. One hundred tons of rice yield approximately 8 tons of acetone and rather more than double this amount of normal butyl alcohol, and, in addition, over one million cubic feet of inflammable gas consisting of approximately equal volumes of carbon dioxide and hydrogen. The residue remaining after the fermentation is completed consists of fibre and insoluble protein which was used as cattle food in England during the war.

There is at present only a limited demand for butyl alcohol, which is used for the manufacture of butyl acetate and as a substitute for amyl alcohol. During the war a process was worked out for the conversion of butyl alcohol into methyl ethyl ketone which it was found could satisfactorily replace acetone in the manufacture of cordite. A number of interesting derivatives of butyl alcohol have been made, but so far none of any great economic importance have been discovered. Investigation continues, however, and if more extensive use can be found for the butyl alcohol this new acetone process is likely to assume greater importance in peace time.

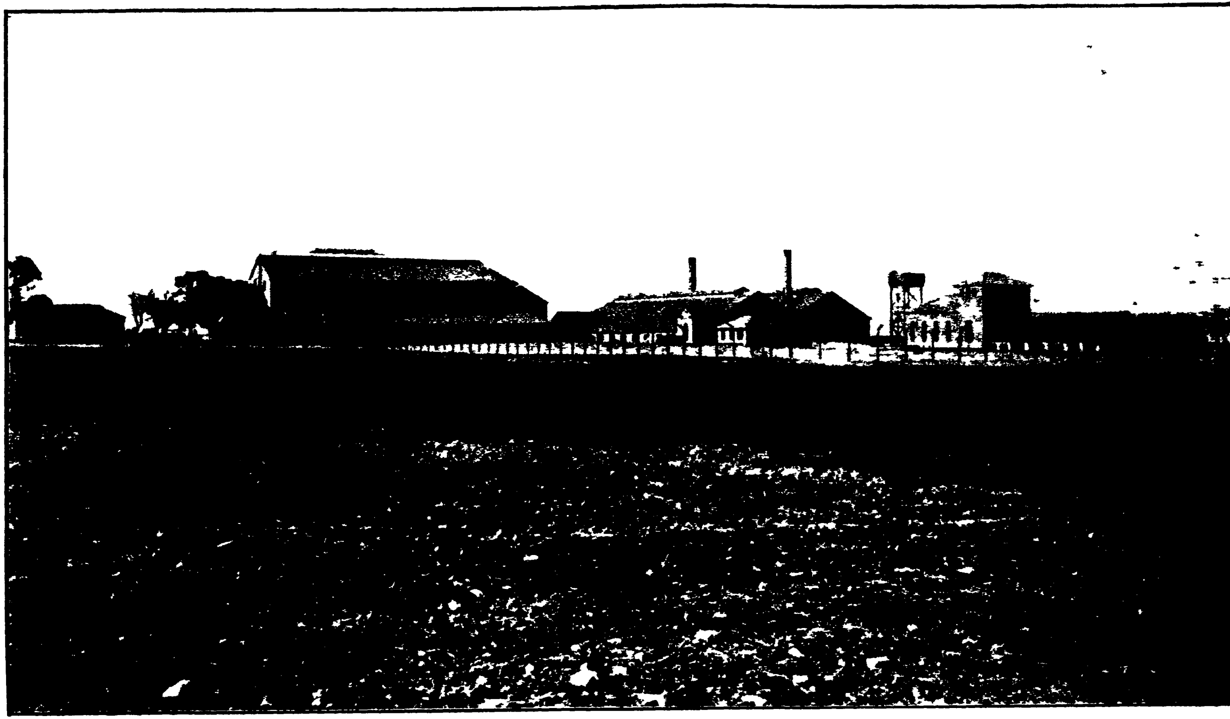
There is a very limited demand in India for hydrogen, and up to the present this by-product has not been separated. It will be seen, therefore, that the economic manufacture of acetone by this fermentation process depends on the extent to which use can be found for the accompanying by-products.

Process plant

The Government Acetone Factory is on the Great Indian Peninsula Railway at Nasik where a siding runs off from the main line into the factory.

Grain storage

A rat-proof godown with a storage capacity for 1,000 tons of grain has been provided. The floor of the godown is raised above the ground level and projects about 9 inches beyond the outer wall. This projection prevents the entrance of vermin and has been found to be a successful method of reducing the damage caused by rats. Occasionally rats are carried into the store in the bags of grain but make their exit in search of water and find it impossible to return.



GOVERNMENT ACETONE FACTORY NASIK (From South)

VAT HOUSE GOVERNMENT ACETONE FACTORY, NASIK

Grain mill

A Robinson's four-pair mill is used to produce a flour suitable for the acetone process from the broken rice or *jowari* which is used. The mill is provided with an automatic weighing machine which records the weight of flour discharged into a mechanical conveyor. This conveyor transports the ground material to wooden hoppers fixed over the cookers. When low-grade coodies are used it is necessary to mill very carefully in order to remove certain constituents of this raw material which have been found detrimental to the acetone fermentation.

Cooker house

From what has been said with regard to the delicate nature of the acetone organism it will be understood that the work carried out in this house has to be most carefully controlled in order to produce a food which the acetone organism can assimilate and in which subsequently the creature can rapidly multiply. This house contains steel cookers which are capable of withstanding high steam pressure. Each cooker has a charge capacity of 3,000 gallons and is provided with stirrers specially designed to produce efficient mixing of a relatively heavy charge of meal with water. The rice meal is run slowly through the manholes into water in the cookers, whilst steam is blowing into the vessel through four steam jets set along the side of the cooker. After the charges of meal have been admitted the manholes are closed down and cooking commences.

The temperature of the porridge is gradually raised to and maintained at 130°C. for some hours, not only to gelatinize the starch but also to destroy those organisms which are always present on the particles of grain. Spore-forming micro-organisms are difficult to kill off, and as grain organisms are the most dangerous enemies of the acetone organism it is essential to ensure that they are rendered *hors de combat* by subjecting the medium to this high temperature before proceeding with the next operation. After this thick porridge has been rendered sterile—and the writer would emphasize that since this new process was introduced we have had to revise our ideas as to what constitutes a fatal heat treatment for micro-organisms—it is discharged into a fermentation vat successively from each cooker by means of its own steam pressure through a 4-inch pipe which has previously been sterilized by steam.

Vat house

The vessels in which the large-scale fermentations are carried out have each a charge capacity of 20,000 gallons. They are made of cast iron plates

with rusted joints, and are provided with steam-heating and water-cooling coils, as well as with a large conical stirrer. Before the vats are ready to receive the porridge prepared as described above they are thoroughly cleaned, and are then partially filled with water taken from a water header. This water contains micro-organisms and the inside of the vessel contains many seats of infection. For this reason the vat and the water are partially sterilized by boiling for some hours, after which they are cooled down by circulating cold water through the cooling coils. It must not be imagined, however, that a few hours' boiling suffices to render the vessel sterile. What the boiling does is to suppress infection sufficiently to render the vessel ready to receive the medium which is discharged into it from the cookers. In this connection the remarks made under 'infection and sterilization' should be noted.

The hot sterile porridge, in being discharged under pressure into the cold water previously prepared in the fermentation vat, evolves large volumes of steam which escape through the manhole. Simultaneously cold water is circulated through the cooling coils, and, as the vessel cools, air is drawn into the free space above the liquid. This air contains micro-organisms, and in order to prevent their entrance to the vat, the air is filtered through approximately a foot of sterile cotton wool. The porridge is therefore thinned down, or the concentration of starch is reduced, by this admixture with water in the vat. The hot mixture is cooled and the water used for cooling is run into the cookers or into other fermentation vats to be used for the preparation of more medium. In this way losses of heat are largely avoided. After the temperature of the medium has been reduced to approximately 37°C. it is ready to receive the inoculant or seed.

Seed pots

The vat house contains aluminium seed vessels each of which has a charge capacity of approximately 800 gallons. These vessels are used for the preparation of the final inoculant of the acetone organism and are provided with thermometers, a stirrer and a coil which can be used both for heating and cooling the medium which is prepared in them. The charge of rice or other starch-containing meal is run into water and the mash is prepared in much the same way as in the cookers. With the object, however, of securing a virile culture of the acetone organism, a thinner mash is made, and, after cooking for several hours at a temperature of approximately 120°C. to destroy all in-

fections, the sterilized medium is cooled down by passing cold water through the coil referred to above. The air which is drawn into the vessel whilst cooling is carefully filtered through sterile cotton wool to remove the micro-organisms which are invariably found on the dust particles in the air. When the mash has been cooled to 37°C., the pail culture of the acetone organism previously prepared in the laboratory and described under 'acetone process' is forced into the seed pot by means of its own gas pressure. After a short time gas evolution from the seed pot commences, and on examining the medium under the microscope we find that the acetone organism has permeated the whole of the medium and has commenced to decompose the starch. After approximately 24 hours, and when the acidity of the medium has reached a maximum, the culture is ready for use. At this point of maximum acidity of the mash the acetone organism appears in great numbers, and under the microscope it usually presents a virile appearance. It will be understood that the object is to secure as many organisms in as virile a condition as possible before running the contents of the seed pot into the 20,000 gallons of medium in the fermentation vat. Experience has indicated that this point is reached when the reaction of the medium in the seed pot has reached a definite value dependent on the concentration of starch which the mash contains. The seed pot culture of the acetone organism is then run into the large vat through a sterilized rubber inoculating hose and the fermentation of the bulk medium commences.

Fermentation in the vat

After inoculation there is a distinct lag; no gas is evolved and outward signs of activity are absent. After four or five hours, however, hydrogen and carbon dioxide begin to escape from the liquid. The velocity of gas evolution gradually increases until it reaches a maximum of approximately 6,000 cubic feet per hour. In addition, the acidity gradually rises to a maximum and then falls again to a steady value of approximately 2·0 ccs. N-10 NaOH per 10 ccs. It must not be imagined that the formation of acetone and butyl alcohol is a linear function of the time of fermentation. It is only when the acidity of the medium begins to fall that acetone is formed. Moreover, although the ratio of the amount of acetone to butyl alcohol in the completely fermented mash is approximately as 1 : 2, this ratio is frequently much less in the earlier stages. It will be obvious from these facts that the mechanism of the reactions which

take place is by no means simple. The inflammable gas evolved is at present discharged through a pipe into the atmosphere. After 30 to 40 hours the fermentation is complete; the medium has clarified and is now ready for distillation.

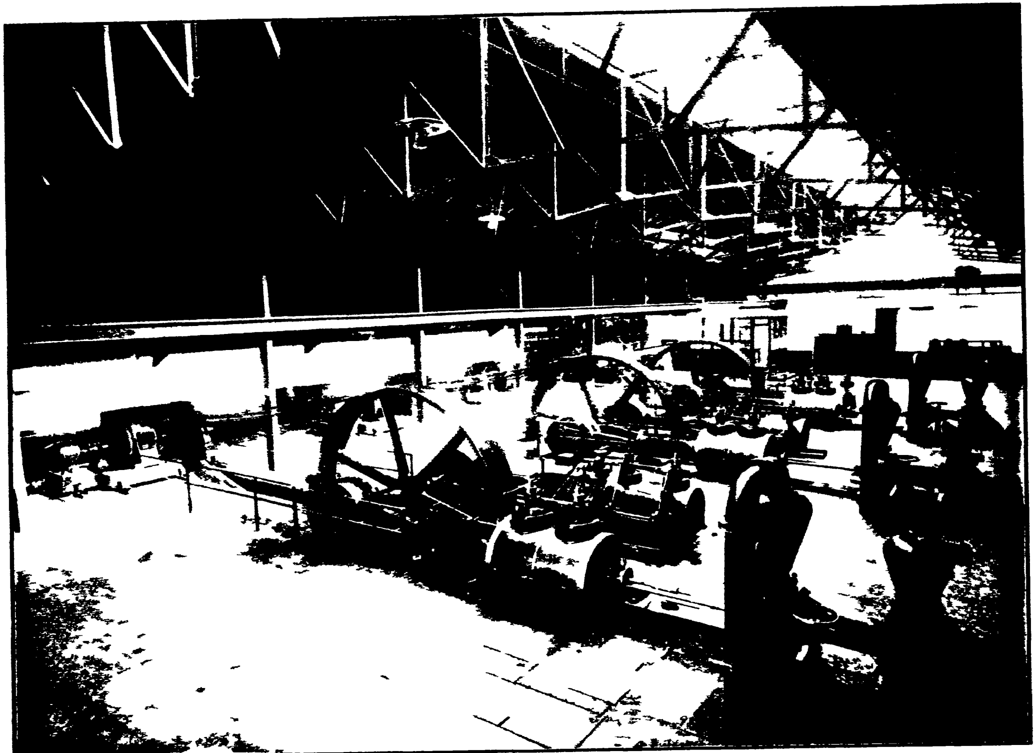
Still house

The fermented wash is pumped from the vats by means of a centrifugal pump to the wash supply tanks placed at the top of the still house. The still house contains two continuous stills, each capable of distilling continuously 1,000—1,200 gallons of wash per hour. They are supplied with regulating valves which give a steady flow of wash through the boiling columns and with pre-heaters in which the hot, spent wash heats up the in-going cold wash. The most interesting device, however, attached to these continuous stills is the automatic steam regulator which controls the steam valve to the boiling columns. This apparatus automatically maintains steady temperatures in the rectifiers and condensers and is capable of very fine adjustment. The acetone is distilled out from the wash and obtained approximately 90 per cent. pure from one boiling column, and the butyl alcohol, which has a higher boiling point, is removed in the second column. Subsequently the acetone is rectified in a small pot still and the butyl alcohol salted out to give the 90 per cent. commercial product. In order to secure complete condensation of acetone in the condensers cooled water is supplied from the refrigerator house which is described below.

From the above description of the process plant it will be understood that all operations have to be timed carefully to secure continuity. Moreover, a great deal of control work, both chemical and bacteriological, is essential in order to obtain entirely satisfactory results; and yet, even at the present time, results are obtained on a factory scale with this ferment from causes which are not determinable with any degree of certainty.

Power, light and water

The Indian Acetone Factory is self-contained, in that, in addition to generating power and pumping and filtering water, it disposes of factory and domestic effluent and houses its staff and daily-paid labourers on an estate covering approximately 150 acres.



ENGINE ROOM GOVERNMENT ACETONE FACTORY NASIK

Seven locomotive-type boilers supply steam for the process operations and for the generation of electricity. The boiler house contains the usual auxiliary plant, such as water-softening apparatus, feed water pumps and induced draft fans. Three horizontal cross compound steam engines of the drop valve type are coupled by rope drives to three alternating current generators. Each engine is capable of developing continuously 212 B.H.P. per hour when run non-condensing, and 260 B.H.P. per hour when run condensing, at 110 revolutions per minute. The three generators are wound three phase star connected, revolving field type and each is suitable for a normal output of 200 kilo-volt ampères at 70 per cent. power factor, 650 volts, 50 periods at 500 revolutions per minute. The main switch board consists of three generator panels fitted with ammeters, ratio meters for the watt and wattless current, kilowatt hour meters for measuring the current generated, and two voltmeters which are common to the three panels. Attached to the main switch board is a Tirrel regulator which enables a steady voltage to be obtained with varying loads.

Boiler and engine houses

The distribution of electric power is controlled by eight feeder panels fitted with the usual ammeters and ratio meters, true watt and wattless current, and all the panels are provided with switches immersed in oil and worked on the remote control system.

All power circuits within the factory are at 650 volts, and the current for lighting the factory roads, bungalows and quarters is stepped down through static transformers to 100 volts. The power for the water pumping station on the Darna River, however, is stepped up through a 'step up static transformer' from 650 volts to 3,250 volts, and at the pumping station is stepped down again to 650 volts for driving the water pumps.

Refrigerator house

The plant in this house supplies cooled water to the still house. Acetone is a very volatile substance, and care has to be taken in distilling the fermented wash to prevent the escape of acetone vapour through the condensers and gas scrubbers in the still house. At this factory the service water temperature is frequently as high as 30°C., and to compensate for the use of a limited condensing surface this water requires to be cooled. Moreover, to avoid the loss of a comparatively large volume of water, the cooling is effected in the refrigerator house and the water returned for use over again. The method adopted may be

regarded as a closed system round which water circulates, becoming hot at one end and cold at the other.

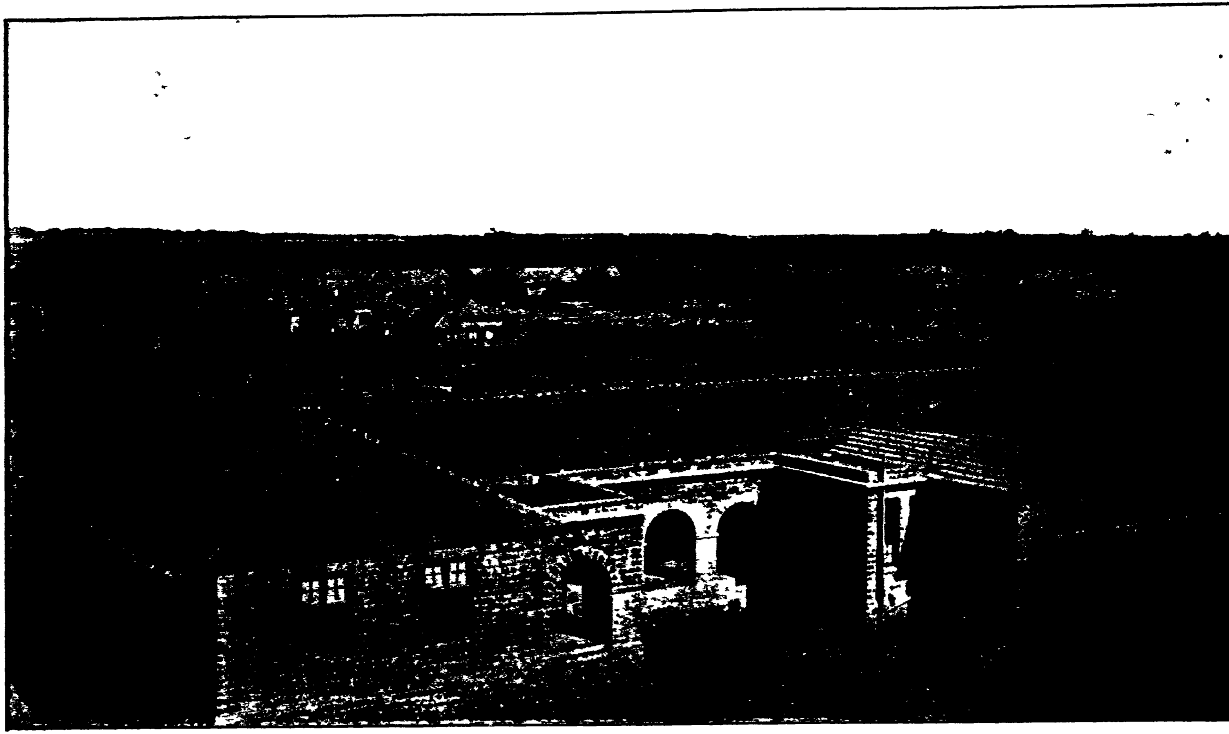
After passing through the condensers in the still house, the first stage of the cooling is effected in a Heenan cooler in which air is blown over the surface of concentric metal cylinders made wet by revolving in the warm water. Evaporation takes place and latent heat is abstracted from the water which is thereby cooled before passing on to the next stage of the cooling. The Heenan cooler reduces the temperature of the water by approximately 20°C.

The refrigerator house contains three double-acting ammonia compressors driven by motors with belt transmission, each of 45 B.H.P. Two rotary pumps circulate water over the ammonia condensing coils and two smaller rotary pumps return the cooled water to the still house. After being pre-cooled, the water from the still house flows into tanks containing the cooling coils and its temperature is suitably reduced prior to being pumped back to the still house. The air temperature naturally affects the power consumption in this house per unit of volume of wash distilled, and care has to be exercised to secure an economic adjustment of the work performed in the refrigerator house in relationship to that being carried out in the still house. In addition this house contains two small motor-driven ammonia compressors which can be used for the manufacture of one ton of ice in 12 hours.

Water supply

A pumping station has been built on the banks of the River Darna which is approximately two miles south of the factory. Three pumps, each with a capacity of 4,500 gallons per hour, coupled direct to motors, are used. The water passes through a preliminary gravel filter prior to entering the pump well. It is conveyed by a 6-inch main to large settling tanks at the factory, where suspended matter is precipitated by the addition of a solution of aluminium sulphate. From the settling tanks the water passes through Jewell filters, which are too well-known to need description here, after which it is chlorinated as it runs into underground storage tanks. The filtered water is distributed to the factory and estate by pumps in No. 2 pump house. This house, in addition to containing two general service pumps and two fire service pumps, contains pumps for circulating the hot water from the engine condensers, and other similar pumps for cooling the hot water returned from the cooling coils in the fermentation vats. The hot water in both cases is sprayed through Korting

CENTRAL AVENUE AND 2ND GRADE QUARTERS GOVERNMENT ACETONE FACTORY NASIK



GENERAL VIEW OF 1ST GRADE QUARTERS, GOVERNMENT ACETONE FACTORY, NASIK.

coolers and falls into spray ponds from which it is pumped into cold water headers.

The effluent from the factory and estate flows into sewage sumps from which it is pumped to the sewage disposal area. The subsoil of this area consists of calcareous permeable *murum* which has been exposed by removing the black surface soil. Excess effluent and monsoon water is pumped on to the *murum* areas, whilst the black soil is used to grow crops. Good crops of sugarcane, tomatoes, cabbages and fodder grasses have been obtained.

Estate

Officers bungalows and quarters for other workers have been built on land adjacent to the factory proper. There are five officers' bungalows, 10 first grade, 20 second grade, 54 third and 280 fourth grade quarters, which have been so disposed as to leave plenty of open space. Trees have been planted along the roads which split up the estate, and all workers, including coolies, are well housed. Government have in this respect set an example which private industrialists would do well to follow. The factory possesses a small isolation hospital and a well equipped dispensary with a resident Sub-Assistant Surgeon, who looks after the well-being of the community.

Definite success has been achieved at the Government Acetone Factory. Over one hundred tons of acetone and more than double this amount of normal butyl alcohol have been manufactured, mainly from raw material which is not used for human consumption. A staff has been trained and the factory put on a sound running basis. The late Indian Munitions Board has, therefore, ensured a supply of acetone for cordite manufacture in India by making use of one only of the manifold processes of decomposition which take place in nature. The need for further investigation, both in India and elsewhere, in the comparatively unexplored field of microbiology ought to require no further emphasis. There is one lesson, however, which it is hoped has been well learnt, and that is that a nation must be able to manufacture essential commodities if she is successfully to wage war.

A. APPLEYARD

REGULATIONS FOR THE PREVENTION OF ACCIDENTS IN INDIAN MINES*

BY

R. R. SIMPSON, M.Sc.,

Chief Inspector of Mines in India

Expansion of the mineral industry

The growth of the mining industry in India is perhaps the best index of the industrial importance of India in the world's markets. This remarkable growth is well illustrated by a single mineral, *i.e.*, coal, the production of which has increased twenty-five times in forty years. The more recent large increase in the production of iron ore is even more striking, and the developments in progress bid fair to place India in the front rank of producers of that mineral. The mining of manganese and mica is subject to violent vicissitudes of demand, whilst the output of gold is slowly decreasing. During the war years there was great activity in wolfram mining, but the demand has now ceased and most of the mines are shut down. The mining of tin, however, is on the increase. Of minerals new to Indian miners, lead, silver and copper are of most importance. The enormous deposit of silver-lead now being mined at Bawdwin in the Northern Shan States, Burma, has been described as the richest mine in the British Empire.

Increase of accidents

This large expansion of the mining industry has not been accomplished without an increase in the number of accidents, and the fact that such increase is at a greater rate than the increase of mineral production is due to the more intensive scale of operations, the greater depths attained, the greater quantities of explosive gas encountered and the increasing use of machinery.

It is not so many years since mining engineers in India could contemplate with satisfaction the low death rate from accidents

* Most of the material used in this article has been taken from a paper read by the author before the Mining and Geological Institute of India in January 1921.

in Indian mines. Since 1901, when the Indian Mines Act was passed, the rate has, however, doubled, and during the last three years a pronounced increase has been maintained. In the upper diagram accompanying this article a graphic comparison is shown between the death rates at all Indian* mines and at all coal mines in Great Britain since the year 1897. The British rate is seen to have been practically constant throughout the period, except for the abnormal figures in 1910 and 1913, when disastrous explosions increased the rates. The Indian rate, on the other hand, despite a downward tendency between 1910 and 1917, has increased until it is now very little below the British rate. If the comparison be based on output, the position of India is greatly inferior. In 1919 the death rate per million tons of coal raised in India was 11·95, as compared with 5·08 in Great Britain for the decennial period ending in 1917.

In the left hand lower diagram the rates for Indian coal mines from 1906 are shown graphically. As might be expected, the rates for all Indian coal mines and for coal mines in Bengal and Bihar and Orissa, where 96 per cent. of the coal is obtained, closely approximate. The figures in 1908, 1910-11, 1913 and 1916 were abnormal, due to the occurrence of severe explosions. During the period the death rate increased by 50 per cent, and, except for the years 1910-11 and 1913, the rate in 1919 was the highest yet recorded, in spite of the fact that only one accident (14 killed) of any magnitude took place during the year. By far the largest death rate in Indian mines is that of Assam coal mines. The curve for Assam in the diagram displays some remarkable peaks. That in 1910 is explained by the occurrence of a disastrous explosion, but those in 1915 and 1917 were due to an increase in the number of ordinary accidents. The rate in 1919 was three and-a-half times greater than that in coal mines in the large coal-fields. Perhaps the comparatively small number of persons employed accounts for the great variation from year to year. Similar great variation is shown in the figures for Baluchistan coal mines where the numbers are still smaller.

The right hand lower diagram illustrates graphically the death rates at mines in India other than coal mines. For all non-coal mines the death rate has increased about one quarter since 1906. The peak in the curve in 1909 was due to activity in gold

* Mines under the Indian Mines Act.

mining developments in Dharwar. That in 1914 was due to a general increase in the number of accidents to which wolfram mining in Burma chiefly contributed. This latter industry first attained prominence in 1911. In 1912 its accident rate was nearly ten times greater than that in other non-coal mines. In 1919, however, it was no more than 2¼ times greater. The curve for manganese mines shows considerable variation. The peak in 1910 is accounted for by a collapse of side in a quarry which killed 11 persons. In 1917 the accident rate had come down almost to *nil*, but now it is at a higher level than in any year except 1910. By far the lowest accident rate for any mineral of importance mined in India is that for mica mining. The rate is only half that of other non-coal mines, and only about one-third of that for all mines in India.

Early records of Indian mining conditions

The records of the Department of Mines in India date from 1894, when Mr. James Grundy, His Majesty's Inspector of Mines in Great Britain, was instructed by the Government of India to enquire into the conditions at Indian mines. A brief mention of some of the details recorded in Mr. Grundy's first report will be of interest.

> Of 62 mines visited only 36 mines had plans; only seven collieries had attempted to extract pillars, only three used explosives in coal getting, and only nine had erected air stoppings: coal fires for cooking or warmth were frequently to be found burning in underground galleries in collieries: at one mine a chain was in use for winding, and at another the winding engines had strap gearing: gins or whims were commonly used for winding: an explosion of gas at Dishergarh colliery caused the death of one European and five Indians.

Notable Indian mining accidents

An accident which occurred in 1897 at one of the Kolar gold mines in Mysore holds the record for the number of lives lost in an Indian mine. It happened on a pay-day when the miners were attempting to leave work a little earlier than usual. The watchmen at the top of a ladder shaft closed the door at the top of the shaft to prevent exit. A large number of men were crowded on the ladders in the shaft, and a panic ensued, during which at least a

hundred men fell from the ladders. Many were crushed to death and their bodies choked the air passage. The total death roll was 52.

In 1899 an accident at the Khost coal mines in Baluchistan caused a loss of 47 lives. A slight explosion of gas took place and shortly after the mine was found to be on fire. At the same collieries in 1908 an explosion, initiated by gas and propagated by coal dust, caused 20 deaths.

In 1912 twenty-three persons were drowned by an irruption of surface water at a coal mine in the Jharia coal-field, and in the following year two similar irruptions in the same coal-field, and one in the Raniganj coal-field, accounted for 27 deaths.

In 1913 the most violent explosion on record in Indian mining annals occurred in the Raniganj coal-field. It was initiated by a slight explosion of gas which set fire to brattice cloth. The whole mine was speedily involved, and 27 persons lost their lives. There were several successive violent explosions, the detonations of which were distinctly heard at a place nineteen miles distant.

In 1916 a collapse of the surface at a colliery in the Jharia coal-field caused the loss of 24 lives.

Causes of accidents

The following is an abridged classification of accidents which have occurred during the last five years in mines under the Indian Mines Act. The figures show the number of lives lost.

Cause	PERIOD						Percentage
	1915	1916	1917	1918	1919	1915-19	
Explosions and suffocation	1	14	4	12	1	32	2·79
Falls of roof and side	93	81	111	126	170	581	50·52
In shafts . .	17	29	16	21	47	130	11·30
Explosives . .	7	4	9	9	7	36	3·13
Irruptions of water, etc.	3	3	4	6	1	17	1·48
Haulage . .	17	12	20	22	41	112	9·74
Miscellaneous underground	13	7	15	16	12	63	5·48
Surface . . .	37	56	22	31	33	179	15·56
TOTAL .	188	206	201	243	312	1,150	100·00

The chief points of interest in this table are the increases in the proportion of accidents due to falls of roof and side, in shafts and by haulage. The percentage (50·52) of accidents by falls of roof and side agrees very closely with the British percentage for the period from 1903 to 1912, which was 50·69 per cent.

Responsibility for these accidents, as gauged by the Inspectors of Mines, over the same quinquennial period from 1915 to 1919 was as detailed below :

	per cent.
Misadventure	50
Fault of deceased	31
Fault of fellow workman	6
Fault of subordinate official	4
Fault of management	9
	100·00

These figures show that one half of the accidents might have been prevented, and there can be little doubt that this is generally true.

Explosions

Considering the fact that in only a relatively small number of Indian mines is explosive gas emitted, the fatalities due to explosions of gas are more numerous than might be expected. Neglecting minor fatalities from this cause, there have been in the last twenty years 8 major explosions causing the loss of 157 lives. In two of these cases the causes were slight ignitions of gas, but the main explosive effect in both was due to coal dust which carried the explosion to all parts of the mines concerned. The fact that certain Indian coal dusts are explosive is alarming, as many of the mines are both dry and dusty, and there are numerous cases where large areas of workings are interconnected. An explosion in an individual colliery might involve as many as six other interconnected collieries. That this danger is by no means remote is shown by the example of Courrières colliery in France, where, in 1906, a blown out shot initiated a coal dust explosion which involved three other interconnected collieries and caused the loss of 1,100 lives. This is the greatest single disaster in the mining annals of the world. Open lights were chiefly in use at the mines.

In two of the eight explosions mentioned above the gases which exploded were generated by mine fires, and the explosions occurred

whilst the fires were being sealed off. Underground fires due to spontaneous combustion are of such common occurrence in the Indian coal-fields that it is fortunate that accidents have not been more numerous.

Although, the author believes, there is only one recorded case of an explosion of gas in India caused by shot firing, yet, in view of the increasing use of explosives in coal mines, it would be advisable in gassy mines to use only 'permitted explosives' on the British Home Office list.

The prevention of explosions in mines can best be effected by improved ventilation methods and the use of safety-lamps only in mines where gas is likely to be found. The most gassy coal seams in India are the Dishergarh and Sanctoria seams, and at all collieries where these seams are being worked safety-lamps are now used or are about to be introduced. It may be hoped that the general introduction of methods of working coal by means of hydraulic packing will prevent outbreaks of fire and be the means of preventing loss of life from this cause.

Falls of roof and side

As is the case in all mining countries, the bulk of mine accidents in India are due to falls of roof and side. Owing to the fact that working places in Indian mines are frequently crowded with numerous workers, the numbers injured in individual accidents of this kind are often greater than in mines in Europe and America. Until recent years the strength of the roofs of Indian coal mines has enabled the mines to be worked in comparative safety, but a rapid change is being brought about by the increase of pillar extraction in thick seams. The robbing of pillars is a fruitful source of accident, particularly where discipline is lax and supervision ineffective. More might be done to check the practice by closer supervision, more substantial fencing of disused workings and the prosecution of offenders. It is rarely that a prosecution is instituted except after an accident. A common departmental punishment for the offence is to withhold payment for robbed coal. The imposition of so inadequate a punishment is an encouragement to offenders. In certain Indian coal mines workers are paid by the length of gallery driven instead of by the weight of coal mined. There is thus no temptation to drive galleries of extreme width or to rob pillars.

The larger accidents by falls of roof and side have been due to three main causes :—

(*a*) Failure to give sufficient slope to over-burden in quarries.

(*b*) The swaying over of props set under masses of roof coal without arrangement to prevent lateral movement.

(*c*) Carrying an excessive area of roof on timber in pillar-extracting operations.

Accidents of these classes are preventible and require nothing more than the application of knowledge and common sense for their avoidance.

Systematic timbering, first introduced at the French collieries at Courrières more than 20 years ago, brought about almost complete immunity from accidents by falls of roof at those collieries, although the strata are weak. For many years now collieries in Baluchistan and the Punjab have applied the system with great success. It was first introduced by mining engineers of the North-Western Railway Company. The collieries in the Punjab which were formerly worked by the Railway Company have since 1911 been worked by Indian owners who have appreciated the benefits of systematic timbering and continued the system with success. All other Indian mine-owners in the Punjab have followed suit. That the system can be applied with advantage in the larger coal-fields has been proved in many instances.

In shafts

Accidents in shafts at Indian mines have increased of late. They caused the loss of no less than 47 lives in 1919. Most of the accidents could be avoided by :

(*a*) careful selection of ropes, chains and all materials used for lowering and raising persons ;

(*b*) thorough daily examination of the same by competent persons ;

(*c*) periodical annealing of chains, etc. ;

(*d*) the use of safety gates on cages ;

(*e*) the provision of convenient protected roads round the edges of shaft bottoms, instead of, or in addition to, the usual pass-byes.

Explosives

Considering the low intelligence of many of the persons who handle explosives in India, the number of accidents arising from their use is not large. Improper treatment of misfired shots is the chief source of accident. Strict enforcement of the rules for procedure in such cases can reduce this risk to a minimum. The misuse of country gunpowder in the coal-fields has caused a regrettable number of fatalities. It has been the practice to issue loose gunpowder to miners on the surface, and to take no further interest in the explosive until it comes to be used underground. The result has been that powder has been kept in dwelling houses and made up into cartridges anywhere, often in the vicinity of domestic fires. In damp weather the powder has been spread in the sun to dry or dried on the tops of boilers or other unsuitable places. That accidents, sometimes involving the death of innocent children, have occurred is not surprising.

Irruptions of water

The chief source of accidents by irruptions of water in Indian mines is heavy rainfall causing the flooding of streams and rivers and the bursting of embankments. When such takes place, the entrances of mines may be submerged or the weight of flood water may break down the surface overlying mine workings. In either case the workings are speedily inundated, sometimes with loss of life. Accidents of this type can be avoided by:

(*a*) refraining from the extension of workings under areas where the cover is weak and insufficient;

(*b*) siting mine entrances on high ground above flood level;

(*c*) providing artificial protection, such as walls or embankments of sufficient length;

(*d*) interfering as little as possible with natural surface drainage, and, where it is necessary so to do, providing culverts of ample dimensions;

(*e*) withdrawal of workpeople at times of abnormal rainfall from workings where there is any possibility of inundation.

Haulage

Until 1918 there was a gradual reduction of the percentage of accidents due to haulage, and the improvement was most marked in the years following the introduction of the special rule applying to coal mines which requires the provision of a second appliance to prevent runaways from the tops of haulage slopes. In 1919, however, the number of haulage fatalities was 41, or nearly double the number in the previous year. Many of those killed were hook-men who accompanied trams in motion. Run-riding on trains proceeding at a speed higher than three miles an hour is prohibited in Great Britain, and a similar prohibition for Indian mines is probably advisable. The majority of those killed were, however, persons not employed in haulage operations. Many of these lives could have been saved if travelling roads separate from the haulage roads had been provided and their use enforced.

Electricity

Accidents from the use of electricity in and about mines have not been numerous. There were three fatalities in 1918 and the same number in 1919. As this form of power is extending so rapidly in Indian mines, the comparative freedom from accident is a testimony to its safety. Modern electrical apparatus is largely 'fool-proof,' but that accidents can happen, even to persons fully acquainted with the danger, is shown by the fact that in 1913 a mine manager was electrocuted, and during the past year the chief engineer of a mine power station was electrocuted and another person holding a similar position elsewhere severely burned. It may not be generally known that a shock from a circuit at 100 volts only has been known to cause death. The circumstances favourable to a fatal shock at a low pressure would seem to include the following: a moist state of the skin, a large area of contact, a considerable length of time during which the person remains in contact. All these conditions can be obtained in mines, where persons wearing the minimum of clothing work in a moist atmosphere in isolated situations.

Surface accidents

The most serious accidents occurring on the surface at mines have been those caused by subsidence of the surface due to the

collapse of mine workings. One such accident in 1916 caused the loss of 24 lives. They can be avoided only by prompt evacuation of the surface as soon as underground conditions favour collapse. Old workings underlying surface buildings should be periodically inspected and their condition noted. All surface buildings should be shown on the mine plans.

Perhaps the most common avoidable accidents are those by drowning in unfenced or insufficiently fenced boiler tanks. In the majority of cases the persons drowned have been young children. Such tanks should be walled to a height of not less than three feet above the ground, and the accumulation of ashes, etc., near the walling should not be allowed.

Hand-shunting of railway wagons is responsible for numerous fatalities, all of which are clearly preventible. Hand-shunting should only be carried on under the direct supervision of a responsible male person, who should either himself control the brake or depute a competent person to do so. Children should not be allowed to assist, and pushing should only be done from behind. Only one wagon at a time should be moved.

Education as a means of prevention

About one half of the accidents in Indian mines are due to the fault of some person, usually the deceased. For any great improvement in this respect we must look to education. In the United States of America* at certain collieries moving pictures are exhibited to the miners with the object of showing them exactly how the work should be done with safety and efficiency. This method of instruction might be used with advantage in India.

"Some large colliery companies in the United States of America have effected a marked improvement by appointing a man to do nothing else than to instruct and to stimulate their workmen in the best way of taking care of themselves. Much, no doubt, depends on getting the right man for the job. He should be, perhaps, a man of their own class to whom the miners will take kindly, and not a colliery official. He goes round amongst them when they are at work, pointing out to them matters that want attention and risks to be avoided, and periodically, say once a week, he holds a meeting

* *Coal mining and the coal miners.* By H. F. Bulman.

at some centre convenient for the workmen, and addresses them on the subject.

"Some companies have a safety Inspector whose services are devoted solely to safety work, and who is responsible to the management for the adoption and enforcement of safety measures.

"Increased safety from accidents has also been achieved by a system of co-operation between colliery owners and insurance companies. Mining engineers appointed by the insurance companies inspect the collieries and fix the rates to be paid according to the relative safety conditions of the colliery. They call attention to points affecting safety which may have been overlooked and recommend measures that may be adopted, and by attention to such points a considerable reduction in the premium to be paid may be effected."*

The National Safety Council of Chicago counts amongst its members over 165 mining companies. It is carrying on in the United States of America a vigorous 'Safety First' campaign. One form of its activities is the issue of striking posters showing the right and the wrong way to perform various mining operations with safety.

First-aid to the injured

The mortality from injuries of a simple character in Indian mines is high. In numerous cases of severe hæmorrhage the patient bleeds to death before skilled assistance arrives. The need for 'first-aid' training is great. It would be of advantage if mine officials were drilled regularly in 'first-aid' methods by the mine doctor. This is actually done at certain Indian mines.

Hospitals

In many of the smaller mining fields of India, particularly those which are controlled from England, there are well equipped hospitals, both for Europeans and Indians, in charge of competent surgeons. In the larger coal-fields, however, there is a general lack of hospital accommodation and skilled surgeons. Many lives are lost and much needless suffering entailed by the absence of proper facilities for the treatment and care of injured and sick employees. A few firms have built small hospitals for Indians and employ competent surgeons, but at the majority of mines the so-called 'doctor' is an unqualified man with only the barest minimum

* *Coal mining and the coal-miners.* By H. F. Bulman

of medical and surgical knowledge; the dispensary consists of a few drugs, etc., kept in the mine office; there is no place for operations or proper facilities for their performance, and patients have to be treated in their own houses. In cases of severe injury patients are carried in doolies a distance of from five to twenty miles to the small Government hospitals at the civil headquarters. As might be expected, they are frequently dead or moribund before arrival. There is no hospital accommodation for Europeans, and European patients have to be sent to Calcutta. At present the only hope of improved facilities would appear to be action by the Mines Boards of Health. It is probable that mine-owners and managers would welcome such action.

Legislation affecting Indian mines

Although Government inspection of mines in India commenced from 1894, there was no undue haste in the enactment of legislation affecting mines. The first step was the appointment of a Committee in 1895 " to submit rules for the working of mines in India." The members of this Committee were Messrs. H. C. Williams, I.C.S., E. Cable, J. Grundy, Inspector of Mines, W. Miller, and Kumar Dakhineswar Malia. The report of the Committee was signed by all the members, but the last mentioned gentleman submitted a note of dissent in which he expressed the opinion that there was no necessity for mining regulations. The Committee drew up a draft Mines Act, and a code of General Rules, and laid down the principles which Special Rules should follow. The draft Act contained 37 sections, and the draft General Rules were 137 in number and applied to mines of all kinds of mineral and quarries 10 feet deep. The proposals met with considerable opposition, and it was not until 1901 that the Indian Mines Act, 1901, became law.

In the same year a rule applying to all mines was made providing for the reporting of accidents; and in 1904 by another rule all mine-owners were required to submit annual returns of labour and output.

It was not until 1904 that rules regulating the working of mines were introduced. In that year a code of twenty-six rules applying to coal mines only became law. Two years later, *i.e.*, in 1906, a code of twenty-eight additional rules applying to coal mines only was made. They relate to coal mine managers' certificates, the

conditions under which they are granted, and the qualifications which the managers of the various classes of coal mines must possess.

In 1907 three rules were added to the Act for the purpose of safeguarding railways. Under these rules notice must be given whenever it is intended to extend mine workings within 50 yards of a railway.

In 1905 a code of Special Rules for the control and guidance of persons employed in coal mines was drafted, but it was not until 1913 that the cumbersome procedure for the establishment of such rules was set in motion.

In 1911 rules regulating the working of manganese, mica and limestone mines were introduced, and in 1916 Special Rules for the control and guidance of persons employed in manganese mines in the Central Provinces were established.

The Indian Electricity Act was passed in 1910, and in 1911 rules regulating the use of electricity in mines became law.

In 1918 four additional rules applying to coal mines in Bengal and in Bihar and Orissa were made. These rules provide for the adequate acquaintance on the part of coal mine officials with the number of persons working in a mine at any given time, and for gates at the entrances to mines which can be entered on foot. In the same year rules for the regulation of tungsten and tin mines in the Tavoy District were made by the Government of Burma.

The Indian Mines Act has now been in force for nearly twenty years, and, although its deficiencies are numerous and apparent, it will probably be conceded that it has worked well and proved to be of benefit both to mine-owners and their employees. The rules for coal mines have received few additions since they became law in 1904 and 1906. Present-day mining practice at the more important coal mines is in advance of the rules, and perhaps the time has now arrived for a further strengthening of the code to bring the laggards into line. A general wish has been expressed for rules requiring the certification of underground sirdars. Suggestions have been made for improvement of the rules relating to plans, inspections, raising and lowering persons, explosives, ventilation and fencings in coal mines.

With respect to mines other than coal mines there is need for rules regulating the working of gold, lead, silver and copper mines, whilst the code for manganese, mica and limestone mines might

profitably be applied to mines of other minerals, such as gems, slate, magnesite, bauxite, clay, iron, chromite and steatite.

The proceedings of the International Labour Conference at Washington in 1919, and the recent inquiry by the Coal Committee, may foreshadow legislation regulating the hours of mine labourers and for the conservation of coal, but these matters are still under the consideration of the Government of India. Both have a distinct bearing upon the subject of the prevention of accidents in mines.

R. R. SIMPSON

MATERNITY BENEFITS FOR INDUSTRIAL WORKERS

BY

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General importance of the question

The need of reducing the rate of infantile mortality and of safeguarding the health of the mother is now generally recognized. Various measures to achieve this end are being advocated in all civilized countries. In this paper we are only concerned with such proposals in so far as they affect industrial workers. "Maternity and Child Welfare" has become a watchword, comprising within its purview many allied movements for social betterment. To study this subject in all its bearings is a difficult task, but it will at once be admitted that the subject should not be dealt with in an isolated manner. The effect of industrial occupation upon the health of women, the possibility of securing sufficient food, the provision of suitable housing arrangements and of adequate medical aid, all have a very direct bearing on infantile mortality.

The Washington proposals

At the first International Labour Conference of the League of Nations, held at Washington in 1919, this principle of conserving the health of mother and child was admitted, and the attempt was made to formulate regulations to secure this object so far as industrial women were concerned. The resolutions drawn up then may briefly be summarized:

(*a*) Women are not to be permitted to work for six weeks after confinement.

(*b*) They are to have the right to leave works six weeks prior to confinement, provided their application is supported by a medical certificate.

(*c*) During absence due to cases falling under (*a*) or (*b*), a woman is to be paid a benefit for the "full and healthy maintenance of herself and her child."

(*d*) Free attendance by a doctor or certified midwife is to be provided as an additional benefit.

(*e*) Half an hour twice a day during working hours is to be allowed for nursing the child.

(*f*) A woman may not be dismissed on account of absence due to pregnancy or confinement.

Such are the proposals, or the 'Draft Convention,' as it is technically called, which the Nations have been asked to ratify. Owing to peculiar social conditions in this country, India has been exempted from immediate ratification, but she has been requested to make a special study of the question and to send in a report to the next conference.

What is being done in other countries, with special reference to Great Britain

Before dealing with the present position in India regarding assistance provided to women at the time of child-birth we may perhaps make a brief reference to what is already being done in other countries in this direction. Full details regarding insurance benefits or allowances payable in respect of enforced absence from work are given in the Report of the Organizing Committee of the Labour Conference.[1] In Great Britain a lump sum of £3 is given as maternity benefit to women who are industrial workers as well as to wives of employed contributors. In Czecho-Slovakia, Germany, Norway and Rumania women receive from 50 to 60 per cent. of their wages, but in Holland and Poland full wages are paid during incapacity; while in Denmark, Norway and France maternity allowance is made dependent on the pecuniary need of the woman. In South Africa women who are dependent on their earnings may be paid an allowance for twelve weeks out of a fund provided by Par-

[1] *Report on the employment of women and children.* Prepared by the Organizing Committee for the International Labour Conference in Washington, 1919. London, Harrison and Sons.

liament, but in Norway a woman may receive benefits up to six months after the birth of the child, if it is breast-fed. Further, in a number of States medical assistance is given in addition to pecuniary aid. In Italy and Holland free attendance of doctor and midwife is not specifically provided. This is true also in Great Britain, yet in that country if a woman is rendered incapable of work during pregnancy, she has the right to sickness benefit and medical attendance as in the case of any other sickness. Further, a complete system of maternity and child welfare centres has also been established there which has in itself resulted in lowering considerably the infantile death rate.

In spite of what is already being done by these countries, ratification of the Draft Convention, even in their case, will mean the extension of benefits and a more general provision of medical aid. It is not easy to introduce the necessary legislation and to arrange for its enforcement. The majority of the countries are, however, unanimous in expressing their desire to carry out these recommendations. Greece has already formally ratified the Convention. Bills to give effect to the Convention are being considered in Denmark, Italy, New Zealand, Rumania, Japan, Spain, France, Czecho-Slovakia, Austria and Chili, and a few other countries are examining the possibility of adapting their existing legislation to meet the requirements of the Draft Convention. The Governments of Belgium and Germany are also contemplating ratification. Great Britain, however, does not propose to ratify the Convention, as it is stated that the existing legislation there and the schemes already in force for maternity and child welfare go beyond the Washington requirements.[1]

The present position in India

Definite suggestions whereby it may gradually be possible to introduce changes in India in accordance with the Washington recommendations will be examined later We may now state briefly, firstly, how far the present customs conform to the proposals, and secondly, what the difficulties are in the way of introducing changes.

The length of time that women abstain from work after confinement varies considerably in different parts of India. Religious and social customs prescribe certain periods, varying from 10 to 40 days, during which a woman cannot return to her ordinary avocation after

[1] *Parliamentary Debates*, Volume 142, No. 64, 27th May 1921.

confinement, but there are no such prohibitions relating to work before delivery. In a great many cases, however, especially where the women belong to a low caste, these rules are not applicable. Pecuniary circumstances seem to be the determining factor regarding length of absence. It is, however, very difficult to obtain exact information regarding length of absence owing to childbirth. Factories do not keep records shewing the causes of non-attendance. Enquiry has elicited the following general statements. In the United Provinces "among the lower castes the period of abstention seldom exceeds a fortnight"; in the Punjab "women workers abstain from work for as short a period as possible on account of pecuniary reasons." In Madras, on the other hand, "usually an interval of two or three months elapses." In Bombay women are said to return to their villages a fortnight before delivery and to return to work a fortnight after. In Bihar and Orissa a month before and a month after is said to be the usual period. In the Central Provinces six weeks' absence is the general rule, though there are some who stay away as long as six months.

Practically no data are available from which one can form an estimate of the numbers who are compelled to leave on account of pregnancy. One firm employing 1,300 women states that during 1919-20, 135 stayed away, but adds that others also may have done so for the same reason without stating the cause.

With regard to the provision of pecuniary aid, which is the next recommendation, the admission must at once be made that maternity benefit schemes are comparatively rare in India. The Basel Mission in Madras had such a scheme and Messrs. Tata Ltd. have just started a liberal one for their employees in the Bombay and Nagpur mills. As this is an almost unique experiment, full details regarding the allowances and the rules are given in the appendix. The Sholapur Spinning and Weaving Mills have also a maternity scheme in force for their employees. Generally speaking, the right to maintenance on the part of the mother is not accepted as a legitimate charge on industry. Information received from Bihar and Orissa, however, goes to shew that a gratuity is occasionally given, and in Assam it is stated that "half pay is given during sickness."

Turning now to the question of facilities for medical aid available for women industrial workers in India, it may be stated that the existing Women's Medical Staff in India is not sufficiently large to provide all the assistance necessary generally, and that in many

factory areas such aid is non-existent. Medical attendance is to some extent provided in Bombay, the Central Provinces, Assam and Bengal. In Madras qualified doctors and midwives attached to public hospitals or dispensaries are stated to be available in most places where there are factories. But against this has to be noted the fact that the majority of such medical officials are men and that their assistance is not sought in maternity cases except in Madras (city). In the United Provinces, Bihar and Orissa, Rajputana and Delhi free attendance is not provided. The supply of qualified medical women in the Puñjab for maternity purposes is understood to be good. The bulk of Indian women are, however, on the whole left to the tender mercies of *dais* or untrained midwives and receive no medical aid whatever.

The recommendation that mothers should be allowed intervals during the day to nurse the child is already observed in India. Women at present seem, on the whole, to be given permission readily to leave their work for this purpose, but no systematic arrangements appear to have been made for allowing women certain definite periods off on this account.

Regarding prohibition of dismissal, enquiry has shewn that women in India are not generally dismissed on account of absence caused by confinement. Owing to the scarcity of labour, women appear to find no difficulty in being reinstated. There may be times and places, however, when labour is more plentiful when it might be advisable to consider whether women should not be legally protected from loss of employment.

To give effect to the main Article of the Convention the varying customs regarding length of absence at present followed in India would have to be made to conform to a minimum period of six weeks. Employers would be required not to engage women within that period, and employees would, under the risk of incurring a fine or penalty, have to stay at home or work in a factory to which such restrictions did not apply.

It is only necessary to state the obligations on each side to realize how impossible it is to bring this prohibition into force at present. Employers could always plead ignorance, except in cases of their own employees who had stayed with them till close on confinement. Employees could easily evade the law, as no record is kept of the name of the mother when a birth is registered. The inspectors

would, in consequence, find it extremely difficult to detect cases of evasion as they would have no reliable sources of information.

In European countries the period of exclusion from work varies from four to eight weeks, of which the major portion must be after the confinement. Great difficulty is experienced generally in enforcing this rule. Attention has already been drawn to the ignorance of the facts both on the part of the employer and the inspector. Replies received to the questionnaire issued by the Organizing Committee of the International Labour Conference "do not indicate that any satisfactory solution of this difficulty has yet been found." "The main safeguard for due observance" the Committee state in their report "is the payment of a Maternity Grant or Benefit which will remove the incentive to a too early return to work"

Possible lines of development

The possibility of introducing the necessary measures to give effect to the Washington proposals has been examined by the Government of India at various meetings between their officers and chambers of Commerce, employers' associations, factory owners and others interested in the question. The matter was also discussed informally at a conference in Simla with representatives of associations concerned with the welfare and medical relief of women and children. This Conference took place at Simla in the Department of Industries on the 9th May 1921.

The general opinion at this conference was that compulsory abstinence from work could not at present be legally enforced for the following reasons:

Women who were refused admittance to factories where such abstinence was made compulsory could easily obtain work in non-regulated factories or in agriculture. Further, employers and inspectors would find it almost impossible to enforce this provision as the system of birth-registration at present in force in most parts of India is not sufficiently accurate or detailed for the purpose in view. Moreover the production of a medical certificate, stating that confinement was likely to take place within six weeks, would in most cases be impossible. Indian women would be most unwilling to obtain such certificates except from women doctors, while the smallness of the existing supply of medical women in India made such a proposal quite impracticable at the present stage.

While agreeing that no immediate action was possible in India to enforce absence from work, it was suggested that employers might be asked to see that fines for absence were not inflicted on women who left within a short time before confinement. It was pointed out that more would probably be gained by enlisting the sympathy of the management than by passing legislation without providing the necessary machinery for enforcing it.

The provision of maternity benefit recommended in the Draft Convention includes medical aid as well as pecuniary help. The feeling at the Conference was that the time has not arrived for the adoption in India of a compulsory benefit scheme. At the same time, the Conference recognized the urgency and importance of the subject. It was finally suggested that employers of labour should be induced to start voluntary schemes and that, where possible, they should be aided by State contributions towards the cost of such schemes. Their attention might also with advantage be drawn to the fact that by offering pecuniary aid at the time of confinement they would not only attract a better class of labour, but that the labour itself would become more stable.

With regard to medical aid it was thought that employers could not be asked to provide the assistance of trained midwives and that such provision should be a matter for the local authorities. At the same time, it was thought possible that the women, whose appointment had already been recommended to the local Governments in connection with the medical supervision of factories and to which reference was made in the debates of the Legislative Assembly, might well be utilized to organize such relief. The smallness of the existing Women's Medical Service in India and the scarcity of women sub-assistant surgeons make it quite impossible at present to guarantee the provision of free attendance by a doctor or certified midwife. The Conference did not, however, wish to suggest that separate maternity schemes should be started for industrial workers. Efforts should, in their opinion, be made to extend the scope of existing organizations so as to include industrial workers and, to enable them to do this, they should be helped by special subsidies. Close co-operation with the All India League for Maternity and Child Welfare was also recommended in all places where the League is established.

Recognition of the difficulties in the way of ratification of the Washington Draft Convention should not be taken as meaning that a policy of laissez-faire should be pursued. It is hoped that in the

immediate future many employers may be persuaded to start voluntary schemes. The development of medical aid throughout India will alone make it possible for women industrial workers to obtain the help they need at the time of confinement. The All India League for Maternity and Child Welfare is already helping considerably in this direction. The extension of the Women's Medical Service is, however, a necessary *sine qua non* of further progress in this direction.

GLADYS M. BROUGHTON

APPENDIX

Rules and Regulations regarding Maternity Allowance at the Bombay and Nagpur Mills of Messrs. Tata Limited

On and from the 1st April 1921 and till further notice Maternity Allowance, Sickness Benefit and Accident Compensation will be allowed to the Employees in accordance with the following Rules:—

I. Maternity Allowance

1. Any woman who has continuously put in at least 11 months' service in the Mill in any of its departments may make a claim for Maternity Allowance.

2. The claim must be supported either by the Mill Doctor or by any qualified medical practitioner, male or female.

3. * The allowance given is to be for a period of two months, the period being the period of two months after confinement, and the amount paid shall be two months' wages including all usual allowances.

4. The date of payment of allowance is to be at the Manager's discretion, and in no case shall the total amount of the allowance be paid in advance at once.

5. Every woman claiming this allowance must give an undertaking to the effect that during the period for which she takes the allowance, she will not work in any Mill, or Factory, or engage herself in any occupation outside her home at all.]

[6. Should a woman go to her native place for confinement, she shall leave her full address behind in the Manager's office, and shall send intimation of delivery to the Manager, who may remit to her the necessary amount.

* In the Bombay Mills Rule 3 runs as follows:
The allowance given is to be for a period of two months, either one month before and after confinement or any other period suitable to individuals as the Manager shall decide, but not exceeding two months in all, and the amount paid shall be two months' wages inclusive of all usual allowances.

NOTES ON INDIAN PRECIOUS STONES* †

BY

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Introduction

From the earliest times of which there is any record to the present day the court and state ceremonies of Indian Princes appear to have been performed amid scenes of brilliant splendour in which the glitter and sparkle of magnificent gems have played an important part. The peoples of India have from time immemorial appreciated the value of beautiful and rare minerals and have vied with each other in their efforts to possess the richest gemstones. Although seldom possessing more than a rudimentary knowledge of mineralogy, many of these people, by familiarity and long experience, can frequently by a glance tell a genuine, valuable stone from a spurious article.

In such a country, where for centuries precious stones have been eagerly sought after, and the people generally are expert in their identification and fully alive to their value, it is not remarkable that new occurrences of precious stones are seldom found now-a-days. The land has been thoroughly searched.

In those areas where from time to time occasional stones are still discovered the villagers invariably search the most likely places, fields, talus slopes, stream beds, etc., after heavy rain or floods. Consequently, so-called mining operations are restricted to old localities in which more modern methods of handling the soils and gravels are remunerative, and prospecting operations in new areas, except in very unfrequented regions, are generally unproductive.

* The word *gem* is used to imply a natural precious stone, cut and polished for ornamental purposes. If the specimen is engraved with a sunk pattern, it becomes an *intaglio*; if it is carved in relief, it is usually called a *cameo*.

† With the permission of the Director, Geological Survey of India.

Best gemstones found loose in river gravels or soil of weathered rock

By far the commonest mode of occurrence of precious stones are as loose stones in the river gravels or the soil of weathered rocks. These sources represent the natural accumulation of countless years, the stones having been derived from a pre-existing rock in the neighbourhood. When these detrital deposits are exhausted the seeker after precious stones is faced with the problem of obtaining them from the original or parent rock. In these *in situ* occurrences the precious minerals are generally widely scattered through the mass of the rock, and their extraction, even from the softer weathered portions of the rock, is expensive; the gemstones are also frequently damaged in the process. Mining for precious stones in India is, therefore, not an attractive proposition. Few companies appear to enjoy a prosperous existence for long without subsidies of one kind or another.

Mechanical treatment of gemstone gravels

In metalliferous mining it is rare to find the operations unassisted by machinery. In the majority of cases the appliances used actually separate the ore from the useless material and produce concentrates. To effect this the most ingenious devices have been employed, depending usually on physical differences between the ore minerals and the gangue, *e.g.*, specific gravity, (Hartz jigs, Wilfley tables, Frue vanners, etc.); surface tension or adhesion, (flotation and oil vacuum processes and the amalgamating plates for free milling gold); magnetic separation, etc.

In the search for gemstones, on the other hand, the keen eyes of the seeker generally have to 'spot' the stone if it is to be found. Yet it has long been known that diamonds, rubies, sapphires, zircons, etc., adhere in a greater or less degree to grease. Quartz sand and other valueless minerals adhere so weakly that they are easily washed off such a surface. The 'grease tables' (modified Wilfley tables) and 'grease belts' (modified Frue vanners) of South Africa probably 'find' 90 per cent. of the diamonds in the Union.

As stated before, the areas in which precious stones are occasionally found have possibly been searched repeatedly. The parent rocks, in many instances, are either too poor to work or have not yet been identified. But there may here be a field for scientific prospecting with suitable appliances. It has been difficult to procure

any information regarding the methods of search employed in the Madras diamond area of Wagra Karur (Lat. 15° 2′ N.: Long. 77° 27′ E.), but in this locality the dark basic rock would probably be the most attractive for experimental treatment. (See La Touche, *Bibliography*, *Part II*, page 163, mentioned below in this note). There can be little doubt that the diamond-bearing gravels of Panna State and the sands of any river in which gemstones have been found would answer equally for such an experiment. It is impossible to say whether the operations would be profitable, but it is certain that more stones would be found than by the existing methods of search.

Occurrences of Indian gemstones

In 1918, Mr. T. H. D. La Touche, a retired member of the Geological Survey of India, prepared a monumental work, in two parts, dealing with "A Bibliography of Indian Geology and Physical Geography (Part I) with an Annotated Index of Minerals of Economic Value (Part II)." This work, which has been published by the Government of India, should be in the hands of all who are interested in the mineral resources of India. In Part II, under Gemstones, on pages 152-185, he discusses very fully the localities and mode of occurrence of the gemstones of India and gives copious references to the literature (found in Part I) of the several localities discussed. Subsequent to the publication of the above volumes a few more occurrences of gemstones have been recorded, but these, with the exception of the Aquamarines of Kashmir, (*cf.*, Middlemiss, *Records of the Geological Survey of India, Vol. XLIX* (*1918-19*) *Part 3*, page 161) are of no economic importance and need not be considered further. Rubies and sapphires, and in a lesser degree spinels, from Burma constitute the most important items of the precious stones of India. The diamonds of Central India (Panna State) and Madras have a very fluctuating output. The trade in garnets and agates has practically ceased. The production of jadestone for the Chinese market has assumed an important position. The output of the Kashmir aquamarines is still uncertain, as the mineral is found *in situ* and the industry is faced with the difficulties of this mode of occurrence.

Foreign sources of supply

No emeralds are at present worked in India, and the stones which come to India are South American (Columbia) gems. Ceylon is the great source of supply for the semi-precious varieties of gem-

stones—moonstone, topaz, etc.—but these sources of supply are sufficiently well known to require no further comment. Abundant references to these foreign localities are to be found in the various works on gemstones. Perhaps the best books are—

(1) *Edelstein Kunde* (1909) by Max Bauer, or the English translation of an earlier edition of this work.

(2) *Precious Stones* (1904) by L. J. Spencer.

Other useful works on the subject are—

(3) *Gemstones* (1919) by G. F. Herbert-Smith.

(4) *A Text Book of Precious Stones* by F. B. Wade.

(5) *Gems and Precious Stones of North America* by G. F. Kunz.

(6) *Mani Mala* by S. M. Tagore.

(7) The chapter on Precious Stones in the yearly edition of *The Mineral Industry*.

(8) The Yearly Mineral Report by the Director, Geological Survey of India in the *Records of the Geological Survey of India*.

(9) Annual Report of the Smithsonian Institution 1911. Paper on *The production and identification of artificial Precious Stones* by N. Heaton.

Statistics

The statistics* shown in Tables I, II, III and IV give an idea of the condition of the Indian market. In Table I, unfortunately, pearls† have been included under the head of precious stones up to April 1919, so that it is impossible to differentiate between the two in the imports and exports previous to that date. There is a very large trade in the importation of pearls from the Persian Gulf and other countries into India, and the figures, from our point of view, are thus vitiated.

* Compiled from the yearly reports published in the *Records of the Geological Survey of India*, from *The Mineral Industry* during the years mentioned and from the *Accounts of the Sea-borne Trade and Navigation of British India* (Official statistics).

† Certain gems are not truly of mineral origin. Amber, although used as an ornament and usually discussed in books on precious stones, is not, strictly speaking, a mineral at all. It is of vegetable origin and consists of more or less altered resin. Coral and mother of pearl are, similarly, not minerals and cannot be classed as precious stones, although they are extensively used for decorative purposes.

Pearls have, from time immemorial, been valued for their beauty and rarity, and, although not of very durable nature, they rank next to the most valuable gemstones. They are of the same composition as the iridescent lining (mother of pearl) of the shells of certain molluscs (chiefly the oyster) and have been formed by the activities of these molluscs—especially those types inhabiting the warm seas and rivers of certain tropical and temperate regions.

There is an important export of jadestone, principally jadeite, from Burma to Canton. This is not included by the Customs authorities under precious stones. Figures are given in Table III.

It is difficult to draw conclusions with regard to India's balance of trade in precious stones. It would appear from Table II, assuming that no pearls were exported, that the total imports of precious stones, valued at Rs. 1,54,609 during the year 1920, were in excess of the exports, valued at Rs. 1,00,090, for the same year. Further, if the values for 1920 are indicative of the average ratio of the imports and exports of precious stones, it will be seen from Table IV that the value of the gemstones, excluding jadestone, obtained in India and Burma is nearly six times as great as the exports of these minerals (Tables I and II).

Statistics of the gemstones trade of British India

TABLE I.—Imports and exports of precious stones, including pearls and excluding jadestone, for the period 1908-20.

TABLE II.—Monthly imports and exports for the years 1918, 1919 and 1920, including pearls and excluding jadestone.

TABLE III.—Exports of jadestone for the period 1913 to 1920

TABLE IV.—Production of precious stones for the period 1913 to 1919.

TABLE I

Value of imports and exports of unset precious stones (excluding jadestone) and pearls

—	Imports	Exports
	£	£
1908	334,599	5,551
1909	548,665	4,055
1910	511,565	2,973
1911	591,397	2,957
1912	717,515	3,587
1913	746,510	3,449
1914	66,141	2,145
1915	326,014	790
1916	456,538	2,952
1917	435,959	2,195
1918	309,669	3,468
1919	2,550* 470,460†	15,733
1920	15,481* 503,483†	11,009

* Precious stones.
† Pearls.

TABLE II

Value of monthly imports and exports of unset precious stones and pearls

Month	Value of imports			Value of exports		
	1918	1919	1920	1918	1919	1920
	Rs.	Rs.	Rs	Rs.	Rs	Rs
			616* 4,33,500†			
January . . .	1,89,021	6,51,605	4,34,116	6,975	15,900	9,706
			7,607* 45,000†			
February . .	67,045	3,52,139	52,607	580	4,900	18,310
			1,357* 80,826†			
March . . .	1,96,280	1,37,080	82,183	2,575	21,850	15,100
		50* 1,09,200†	1,364* 6,57,000†			
April . . .	20,608	1,09,250	6,58,364	1,300	9,175	10,000
		237* 58,000†	42,996* 34,000†			
May . . .	9,415	58,237	76,996	3,600	500	2,768
		7,208* 1,65,200†	1,471* 1,26,500†			
June . . .	10,450	1,72,408	1,27,971	4,000	4,050	9,845
		106* 5,21,000†	4,601* 74,500†			
July . . .	2,24,734	5,21,106	79,101	450	..	11,900
		225* 9,51,500†	4,951* 2,21,000†			
August . .	32,155	9,51,725	2,25,951	..	55,800	8,940
		28* 5,35,250†	35,215* 3,28,500†			
September . .	6,99,635	5,35,278	3,63,715	500	10,700	5,115
		4,006* 5,00,350†	4,214* 10,32,500†			
October . .	5,80,810	5,04,356	10,36,714	..	18,600	7,670
		1,918* 10,78,600†	3,630* 15,89,500†			
November . .	2,76,566	10,80,518	15,93,130	..	2,100	9,025
		11,824* 7,85,500†	46,787* 4,11,500†			
December . .	7,89,978	7,97,324	4,58,287	3,000	13,760	1,711

* Precious stones.
† Pearls.

TABLE III

Exports of jadestone from Burma

—	Quantity	Value
	Cwt.	£
1913	2,961	24,903
1914	2,959	40,092
1915	5,001	52,070
1916	4,486	48,926
1917	3,951	67,502
1918	4,026	124,113
1919	2,977	58,068
1920	4,436	120,380

TABLE IV

Production of precious stones in India

Name of stone	1913	1914	1915	1916	1917	1918	1919	
1. Diamonds	115·7	54·65	35·99	20·42	18·2	73·29	311·9	Carats
	1,791	791	603	361	1,827	2,625	20,825	£
2. Rubies	203,925	193,333	167,904	136,783	132,409	101,637	88,847	Carats
	50,944	40,781	34,881	35,848	43,575	34,491	87,434	£
3. Sapphires	21,358	56,709	39,718	34,100	32,369	34,949	47,286	Carats
	4,028	2,052	1,276	1,442	8,017	5,571	20,170	£
4. Spinel	53,428	54,830	43,827	38,841	33,422	27,529	22,444	Carats
	570	300	141	223	239	248	483	£
5. Aquamarine	...	...	3·5 cwt.*	4·13 cwt.†	26,000 Carats	...	...	...
	...	...	...	...	£297	£180	...	...
6. Amber	10	13	11·5	5·5	59·6	2·9	7·4	Cwt.
	29	274	199	157	684	87	616	£
7. Agate	...	101	508	143	120	...	...	Tons.
	...	175	1,019	783	255	...	...	£
8. Garnet	334	21,906	115	475	...	...	...	Cwt.
	1,288	4,806	...	...	...	...	...	£
9. Jadestone	3,281	3,764·75	3,692·75	3,783·35	3,961·28	3,203·1	2,019·2	Cwt.
	12,780	13,643	12,678	9,315	28,931	25,209	28,045	£

* Kashmir.
† @ 4·5 to 7 annas a carat.

Tax on imported gemstones

Any legislation affecting the trade must not put such a severe tax on imported unset or uncut stones as to prohibit honest dealers from competing with importers of smuggled gemstones.

Trade in uncut stones

The ramifications of the trade in rough stones are generally very complicated or confidential. Much depends on the knowledge and energy of the buyers. Direct dealing, though it frequently entails a good deal of inconvenience, appears to be the only satisfactory method of carrying on business with small dealers. In consequence of this secrecy these transactions are sometimes looked upon with suspicion, but intentional frauds between dealers in precious stones are comparatively rare. The public, in general, are usually ignorant of the genuine or false character of the stones they purchase, and it is a wonderful testimony to the honesty of the firms from which they buy that the gems they obtain are so seldom spurious.

The following remarks by the Managing Director of a typical gem mining company as to the disposal of the gems obtained by his company are of interest. He says:

"Apparently nearly all gemstones, both in the rough and cut, are sold throughout the world by private dealing, and in a manner which bears a close resemblance to the well known and traditional bargaining methods of the East. A price is fixed by the seller, an offer is made by a would-be purchaser and bargaining continues until a price is finally offered that does or does not satisfy the seller, when the negotiation closes. The seller tries to induce as many dealers as possible to bid privately against one another, and seller and buyers in this manner arrive at the estimates of value made by one another and eventually reach a tolerable unanimity. As there can be in coloured stones no average standard of value, this method enables the market to collectively price a stone or parcel of stones in a roughly approximate fashion."

There is said to be an Indian rule for the valuation of the more precious stones when these exceed the weight of one carat. The rule is—"The value of a stone is equal to the square of its weight (w) multiplied by the value of one carat of that stone (P). Thus $V = P\,w^2$." However, there are various causes which modify the

values of stones; exhaustion of well-known sources of supply, or a large demand, invariably produces a rise in prices; whilst a rich discovery of stones, or the sudden placing of a large accumulation of stock on the market, results in a lowering of the prices. Valuable gems and excellent stones of large size and great beauty are always sought after and can be disposed of at high prices.

Cutting centres for gemstones

A large number of Indian stones, chiefly rubies and sapphires and some diamonds, find their way to Europe, usually to Amsterdam, where they are cut by the ring of jewel merchants of that city. A German firm, Idar-Obersteiner Industrie, had obtained a large gem cutting trade before the war. Recently the Belgian Government has established an important trade of this nature at Antwerp. But perhaps the most important of these new centres is the Bernard Oppenheimer Diamond Works, Limited, of Brighton. It has cutting factories at Wrexham in Wales and also at Fort William in Scotland. The employés are largely men who have been wounded or crippled in the war. In India a cutting and polishing industry for precious stones has existed in a small way at Delhi, Jubbulpore, Ratanpur and various other places, but the workmanship is not of the same high order as that of Europe. Many large firms have expert workmen and are capable of producing very good work, though, as a rule, the best cut gems come from Europe.

Weights, carat and *rati*

Much confusion has been caused by the fluctuating value of the so-called standard by which precious stones are weighed in different countries and in different towns of the same country. The carat,* for example, has the following values in—

	Grams.
London	0·20530
Amsterdam	0·20570
Paris	0·20550
Berlin	0·20544
Frankfurt-on-Main	0·20577
Leipzig	0·20500

*According to G. F. Herbert-Smith in *Gemstones (1919)*, page 84, the word is derived from the Greek *κεράτιον*, little horn, the shape of the pod of the locust tree *Ceratonia siliqua*, the seeds of which were evidently used for weights like the barley corn. Max Bauer in *Precious Stones* (1904), page 103, supposes the name to be a modification of "Kuara" an African leguminous tree, *Erythrina abyssinia*, the dried fruit of which is said to have been used in early times for weighing gold.

	Grams
Vienna	0·20613
Venice	0·20700
Livorno	0·21599
Florence	0·19720
Madrid	0·20539
Lisbon	0·20575
Madras	0·20735
Borneo	0·20500
Batavia	0·20500

In France, Belgium and the United States the carat has been fixed as 0·2 gram (one fifth of a gram) and it is expected that most countries will follow.

Among Indian jewel merchants there is a definite system of weights of which the *rati* is about the equivalent of the European carat (it varies from $\frac{7}{8}$ths to $\frac{10}{11}$ths the weight of the variable carat). The *rati* being the approximate weight of the scarlet and black, bead-like seed of the plant *Abrus precatorius*. Mr. E. Vredenburg, (*Records of the Geological Survey of India*, Vol. XXXIII, part 4, page 284) found that a Panna diamond which was stated to weigh 2 *ratis* 3 *bishas* (2·15 *ratis*) weighed 0·4151 gram. The *rati* would, therefore, have a value equal to 0·19307 gram and not be very dissimilar to the carat. However, like the carat, the *rati* has not an equal value in different places. The Indian scale of weights is—

One tola equals 16 annas or 12 *mashas*.*
One *masha* equals 8 *ratis*.
One anna equals 6 *ratis*.
One *rati* equals 4 *dhans*.†
One *rati* equals 20 *bishas*.‡

Identification of gemstones

It is a remarkable fact that very few jewellers employ any exact scientific aids for the accurate determination of gemstones. Some firms have dichroscopes which are safely locked away. Others only have pocket lenses and rely entirely on the judgment of an experienced, unscientific expert. When it is remembered that many of the precious stones handled by important jewellers are of great value and that these firms cherish with pride their reputation for straight dealing, it is evident that the question of accuracy becomes

* *Mashkalai* (Bengali) from the Sanskrit *mash*, a bean or pulse identified as *phaseolus diatus*.
† The name *dhan* in Hindi stands for an unhusked grain of rice.
‡ From the Sanskrit word *bingsha* for twenty, a *bisha* or *biswa* being a twentieth part.

one of importance. Mistakes, sometimes to the advantage of the firm but possibly oftener to its disadvantage, must inevitably occur. Their frequency or rarity, of course, depends on the variety of stones dealt with. The full extent of these errors cannot become known until the opinion of the expert is regularly checked by scientific tests.

The cost of the apparatus required for these tests is so small and their manipulation, in performing the tests, so simple that it is a great pity that these methods of determination are not enforced by the several firms engaged in the buying and selling of precious stones and gems.

Although there are descriptions of these methods of identification in almost every book on precious stones, the information so supplied is seldom in an attractive, practical form. Beauty, durability and rarity are the fundamental factors in determining between precious and semi-precious stones. Rarity is an accidental factor which cannot be tested except by experience. Durability, on the other hand, depends entirely on physical considerations and allows of determination. Beauty, while depending on questions of colour and the quality of the cutting and polishing of the gemstone, is also dependent on the transparent, translucent or opaque nature of the substance. All the important precious stones (excluding pearls, as previously explained) are very hard and transparent to translucent and can, therefore, be subjected to optical tests.

Mr. N. Heaton (see the *Annual Report of the Smithsonian Institution*, 1911, page 219) states as follows the properties which influence the value of precious stones and which are used as a means of identification.

- Beauty
  - Colour
  - Structure
    - Cleavage
    - Lamination
    - Inclusions
  - Optical properties
    - Refractive index (refractometer)
    - Double refraction (polariscope)
    - Pleochroism (dichroscope)
    - Dispersion
    - Absorption spectrum (spectroscope)
- Durability
  - Hardness . . . Streak and scratch
  - Toughness
  - Chemical composition

N.B.—Additional means for identification
- Specific gravity . . Heavy liquids, etc.
- Thermal conductivity
- Pyro-electrical properties
- X-ray examination

Hardness

The precious stones are usually very hard, about 8 in the scale of hardness, where feldspar=6, quartz=7, topaz=8 and corundum =9. Gemstones below the hardness of topaz are generally of the semi-precious type. Occasionally, by rarity and colour and beauty, varieties of these semi-precious stones may be classed as, or mistaken for, more valuable stones, but the hardness test should prove a useful guide in determining the true precious stone. Thus jargoon (colourless zircon) has a hardness of 7·5 whereas the white sapphire (colourless corundum) is 9 and the diamond is 10. The emerald, on the other hand, has a hardness of 7·5, whereas the oriental emerald (green corundum) is 9, the Brazilian emerald (green tourmaline) is 7 and the Uralian emerald, demantoid (green garnet), has a hardness of only 6·5.

Specific gravity

The ordinary methods of determining specific gravity by (1) hydrostatic weighing are too well-known to require description. The (2) pycnometer, or specific gravity bottle, is also a familiar mode of determination but is not as convenient or handy as the procedure by (3) heavy liquids. If the density of the liquid be adjusted, it is possible to test a gem by dropping it into the liquid and seeing whether it sinks or floats. Various liquids have been used and most of them have some slight draw-backs. For example, the common methylene iodide has, when pure, a density of 3·324 *i.e.*, less than the diamond (3·52). In this condition the liquid rapidly becomes so dark that it is difficult to see the stone which has been placed in it. Methylene iodide can be mixed in all proportions with benzol (·88) or toluol (·86). Acetylene tetra-bromide (2·95) is miscible with toluol and is useful for the lighter gemstones. A more convenient liquid is the saturated solution of potassium iodide and mercuric iodide in water, known as Sonstadt's solution (3·085 at 12°C), which can be diluted with water. Like the preceding solutions it is only available for separating heavy minerals from those of lower specific gravity than the liquid. It is highly poisonous. Crystals of boro-tungstate of cadmium, if heated to 75°C, fuse to a yellow liquid having a density of 3·55. If dissolved in water, the saturated solution at 15°C has a density of 3·28 and is known as Klein's solution: it can be diluted to any extent with water and is harmless.

Retger's salt, silver-thallium nitrate, melts at 75°C and has a density of 4·6. It can be dissolved in water to produce liquids of high density suitable for distinguishing diamond from colourless zircon. It is highly poisonous and expensive. By suitable dilution these liquids can be adjusted very accurately to a definite density and the gemstones tested by dropping them into the liquid. Test sinkers, ranging from a density of 2·00 to 4·5, can be made by Messrs. Baird and Tatlock and callibrated by the National Physical Laboratory.

Refractive index and the refractometer

The Herbert-Smith refractometer is one of the most convenient instruments for rapidly determining the refractive index of gems. It is based on the method of total reflection of light from the plane separating two translucent media. A facet of the gem is placed, with a drop of methylene iodide, on the flat surface of a glass hemisphere. Light is permitted to enter the glass hemisphere from one side below the plane of junction between the gem and the flat surface of the glass hemisphere. Some of this light is totally reflected into the hemisphere and illuminates a scale on which the index of refraction of the gemstone is read off directly. The apparatus is limited in range to the index of refraction of the glass of the hemisphere (1·79)* and so is not available for zircon (1·927-1·980) or diamond (2·417) but can test corundum (1·761-1·770). The apparatus can be procured complete with an explanatory booklet from the makers, J. H. Steward Limited, 406 and 457 Strand, London, W. C. 2.

Pleochroism and the dichroscope

The colour of some crystals or gemstones varies with the direction in which they are cut or viewed. This is known as pleochroism and is due to double refraction. A dichroscope is simply a piece of Iceland spar, set in a cylindrical frame, provided with a small aperture at one end and open at the other. When held up to the

* Unfortunately the very highly refracting glasses are soft. Thus a 'dense' glass having a refractive index of 1·804 is so soft that the glass surface becomes easily scratched and corroded and the value of the instrument seriously impaired, if not rendered useless. Great care should be taken when using the Herbert-Smith refractometer for the reason.

light the dichroscope shows two images side by side. If a pleochroic crystal is examined by the dichroscope, two differently coloured images are seen simultaneously. Zircon, beryl, corundum, topaz, etc., have double refraction, so that coloured stones will show pleochroism. Diamond, spinel, garnet, and glass have single refraction and are not pleochroic.

TABLE V

FOR ASSISTANCE IN THE DETERMINATION OF GEMSTONES

List of principal precious stones and their characters (for further details see Precious stones, 1904, *by Max Bauer)*

—	Species	Variety	Composition	No.	Colour	Hardness	Specific Gravity	Refractive index	Refraction	REMARKS
Element	Diamond	,,	Carbon	1	Colourless Transparent = T.	10	3·52	2·417	Single	
Oxides	Corundum	Ruby	Oxide of aluminium	2	Red T	9	4·03	1 761 to 1·770	Double	Pleochroic = P
		Sapphire		3	Blue T	9	4·03			
		Oriental emerald, etc.		4	Green T	9	4·03			
	Quartz	Rock crystal	Silica	5	Colourless T	7	2·657	1·544 to 1·553	,,	Pleochroic
		Amethyst		6	Violet T	7	2·657			
		Cairngorm, etc.		7	Yellow T	7	2·657			
		Chalcedony		8	Dull white	6·5	2·45			
		Opal		9	Translucent = T	6	2·15	1·454	,,	Opalescent
Aluminates	Spinel	Balas ruby	Magnesium aluminate.	10	Red T	8	3·6	1·726	Single	
		Rubicelle		11	Yellow T	8	3·6			
		Pleonaste		12	Green T	8	3·6			
	Chrysoberyl	Cymophane	Beryllium aluminate	13	Greenish T	8·5	3·73	1·746 to 1·753	Double	Pleochroic
		Alexandrite		14	Olive green T	8·5	3·73			
Silicates	Garnet	Hessonite	Calcium aluminium silicate.	15	Orange T	7·25	3·61	1·745	Single	
		Pyrope	Magnesium aluminium silicate.	16	Blood red T	7·25	3·78	1·755	,,	
		Almandine	Iron aluminium silicate.	17	Deep red T	7·25	4·05	1·790	,,	
		Demantoid (andradite).	Calcium iron silicate.	18	Green T	6·5	3·84	1·835	,,	
	Beryl	Emerald	Beryllium aluminium silicate.	19	Green T	8 to 7·5	2·695	1·572 to 1·577	Double	Pleochroic feeble
		Aquamarine		20	Bluish green T	7·5	2·695			
		Rosterite		21	Pink rose T	7·5	2·695			

List of principal precious stones and their characters (for further details see Precious stones, 1904, *by Max Bauer)* —contd.

—	Species	Variety	Composition	No.	Colour	Hardness	Specific gravity	Refractive index	Refraction	REMARKS
Silicates—concld.	Olivine	Peridot (chrysolite).	Magnesium iron silicate.	22	Yellow green T	6·5 to 7·0	3·4	1·659 to 1·697	Double	Pleochroism distinct
	Sphene	..	Calcium titanium silicate.	23	Brown T	5·5	3·4	1·901 to 1·985	,,	Pleochroism strong
	Benitoite	..	Barium titanium silicate.	24	Blue T	6·5	3·645	1·755 to 1·799	,,	,,
	Spodumene	Kunzite	Lithium aluminium silicate.	25	Lilac T	6·5 to 7	3·185	1·66 to 1·675	,,	,,
	Topaz	..	Aluminium fluo-silicate.	26	Yellow T	8	3·55	1·618 to 1·627	,,	Pleochroism distinct
	Tourmaline	Achroite		27	Colourless T	7·25	3·022			
		Rubellite		28	Red T	7·25	3·08			Pleochroism distinct to strong
		Indicolite	Complex boro-aluminium silicate	29	Blue T	7·25	3·10	1·623 to 1·643	,,	Pleochroism strong
		Brazilian emerald		30	Green T	7·25	3·10			
	Zircon	Jargoon	Zirconium silicate	31	Colourless T	7·25	4·07	1·815	Almost single	
		Hyacinth	..	32	Reddish yellow T	7·25	4·6 to 7	1·927 to 1·980	Double	
	Dichroite	Water sapphire.	Iron magnesium aluminium silicate.	33	Blue T	7	2·60 to 2·66	1·543 to 1·551	,,	
	Epidote	Pistacite	Hydrous silicate of aluminium and calcium.	34	Greenish T	6 to 7	3·375	1·735 to 1·76	,,	,,
	Kyanite	..	Aluminium silicate	35	Blue T	5 to 7	3·61	1·72 to 1·73	,,	Pleochroism distinct
	Feldspar	Moonstone	Potassium aluminium silicate	36	Colourless T	6 to 7	2·57	1·53 to 1·54	,,	
	Idocrase	..	Complicate hydrous silicate.	37	Yellow to green T	6·5	3·40	1·714 to 1·719	Single	Pleochroism distinct
	Jadeite	(Jadestone)	Sodium aluminium silicate.	38	White to gray and green.	6·5 to 7	3·33	..		
	Nephrite	..	Calcium magnesium silicate.	39	White to gray and green.	5·5 to 6	3·00	Opaque		
	Lapis Lazuli.	..	Calcite coloured by Lazurite, haüynite and sodalite.	40	Blue	5·5	2·4	,,		
Phosphate	Turquoise	..	Hydrous aluminium phosphate.	41	Green	6	2·6 to 2·8	,,		
Carbonate	Malachite	..	Copper carbonate	42	Green	3·5	3·7 to 3·8	,,		

Popular and trade names

It frequently happens that the public name for certain gem-stones gives quite a misleading idea of the true character of the stones. Most large diamonds have names, but when the price of a large stone is absurdly cheap it is evident that some other mineral is being traded. Such names as 'Mari diamonds' etc., usually refer to beautifully clear quartz crystals.

The following list of names of popular stones has been drawn up to show the corresponding mineralogical name of the mineral concerned :—

Popular name	Mineralogical name
Adelaide ruby	Garnet (almandine)
Alexandrian turquoise	Turquoise from Sinai
Amazonstone	Green microcline
Arizona ruby	Garnet (pyrope)
Asparagus stones	Yellow apatite
Balas ruby	Rose red spinel
Baroque pearls	Usually pearls of irregular form
Bohemian ruby	Rose quartz
" topaz	Yellow quartz, citrine
Brazilian emerald	Green tourmaline
" peridot	Yellow green tourmaline
" ruby	Red topaz.
" sapphire	Blue topaz, also the blue tourmaline, indicolite
" topaz	Yellow topaz
Cape chrysolite	Prehnite
" ruby	Garnet (pyrope)
Ceylonese chrysolite	Yellow green tourmaline
" opal	Moonstone, adularia
" peridot	Green tourmaline
" ruby	Garnet (almandine)
Cinnamon stone	Garnet (hessonite)
Colorado ruby	Garnet (pyrope)
Evening emerald	Peridot (olivine)
Elie rubies	Garnet (pyrope)
False amethyst	Violet fluorspar
" diamond	Quartz crystals
" emerald	Green fluorspar
" lapis lazuli	Blue agate
" ruby	Red fluorspar
" sapphire	Blue fluorspar
" topaz	Yellow fluorspar
Golden beryl	Yellow beryl

Popular name	Mineralogical name
Golden topaz	Golden yellow quartz, citrine
Indian topaz	Saffron yellow quartz, citrine
Jacinth	Yellow red zircon
Jade	Jadeite, normally also includes nephrite
Jargoon	Pale yellow zircon
King topaz	Yellow corundum
Kollin garnets	Garnet (almandine)
Mari diamonds	Doubly terminated quartz crystals
Matura diamonds	Colourless zircon
Mocha stone	Dendritic agate
Mother of emerald	Prase, green quartz.
,, ruby	Red spinel
Occidental amethyst	Violet quartz
,, diamond	Quartz, rock crystal
,, topaz	Yellow quartz
Oriental almandine	Red garnet
,, amethyst	Violet corundum
,, aquamarine	Greenish blue corundum
,, chrysolite	Yellow green corundum
,, emerald	Green corundum
,, hyacinth	Pale red corundum
,, ruby	Red corundum
,, sapphire	Blue corundum
,, topaz	Yellow corundum
Russian topaz	Topaz
Scotch topaz	Cairngorm
Siberian ruby	Red tourmaline (rubellite)
Spanish or Peruvian emerald	Green beryl (true emerald)
Spanish topaz	Citrine (yellow quartz)
Syriam garnet	Finest ruby coloured garnets
Uralian emerald	Green garnet
Water chrysolite	Moldavite
,, sapphire	Cordierite
,, opal	Moonstone

Artificial and imitation stones

It must be remembered that the manufacture of many artificial stones is an accomplished fact. By artificial stones (synthetic gemstones) are meant such productions as possess the same chemical composition and physical constants as natural precious stones: they differ from these only in minute details. Other varieties are truly imitations. The manufacture of *imitation* gems was brought to a great state of perfection by Strasser of Vienna, hence the name

'Strass' though the word 'paste' is of more common application for these spurious articles. The glass is specially prepared so as to have the necessary optical properties compatible with a fair amount of durability. These articles can, however, be readily distinguished from genuine or artificial gemstones, as may be seen in the following table of comparative qualities.

Identification of imitation precious stones (after Heaton).

Imitation (paste)	Genuine stones
1. Refractive index seldom exceeds 1·65 .	1. Refractive index up to 2·4
2. Single refraction or strained false double refraction	2. Chiefly double refracting except diamond spinel and garnet
3. Never pleochroic	3. Often with strong pleochroism
4. Hardness always below 7 . . .	4. Hardness chiefly above 7
5. Specific gravity usually above 4 . .	5. Specific gravity usually below 4
6. Thermal conductivity low . . .	6. Thermal conductivity comparatively high (feels colder to the touch)
7. Spherical bubbles and curved striae .	7. Lamination or inclusions
8. Opaque to X rays	8. Transparent or translucent to X rays

Doublets

Most jewellers are fully aware of the use of doublets and triplets —thin slices of the genuine stone cemented with Canada balsam on colour 'paste' stones—for overcoming the test for hardness : all such imitations are detected in oil or boiling water when the structure of the composite will be visible or the stone will fall to pieces.

Artificial diamonds

The manufacture of artificial stones is most frequently confined to those of simple composition of which the natural stone is of a precious variety. It does not usually pay to produce synthetic gemstones of complicated composition if the natural stone is common. The diamond is exceedingly difficult to reproduce synthetically although the composition is simple.

Synthetic rubies

The artificial production of crystalline corundum by the Verneuil process[1] is much simpler, and by introducing a small proportion of potassium or ammonium chromate the colour of the ruby has been accurately obtained.

Synthetic sapphires

Similarly, by the use of titanium oxide the colour of the sapphire has been obtained. And it is now possible to obtain artificial rubies and sapphires of almost any shade of colour, quality or size at a few shillings per

[1] See *Annales de Chemie et de Physique* (September 1904) "*Memoire sur la reproduction artificielle du rubis par fusion*" by M. A. Verneuil.

carat. The substance is identical with the natural mineral, both physically and optically. Yet the artificial product can usually be distinguished from the natural gemstone. In the rough it does not appear to develop a crystalline outline and invariably possesses the shape of a congealed liquid or glass. It is the exception to find the natural stone free of inclusions, technically known as 'silk,' caused by microscopic, elongated, drawn out bubbles or cavities all lying in one plane. In the artificial stone there is greater uniformity of colour and the included bubbles are spherical in shape. A careful examination of the cut stone (gem) with a lens is usually sufficient to detect these differences, but by placing the stone in a little cell filled with a highly refracting liquid to obtain uniform illumination and examining the stone in transmitted light the minutest details can be observed. In a perfectly flawless stone it would be impossible to decide.

Herbert-Smith ('*Gemstones*,' 1919, page 123) says "It is no secret that some thousands of carats of manufactured rubies are shipped annually to the East. *Caveat emptor*."

Reconstructed imitation emeralds

Reconstructed emeralds have been made, but the product is amorphous and does not, therefore, possess the double refraction and crystalline structure of the natural gemstone. Artificial emeralds have evidently not been obtained. When the problems connected with their manufacture are solved the methods of detection will probably be the same as with synthetic rubies and sapphires.

Artificial turquoise

Artificial turquoise has long been known. It is made by precipitating hydrated phosphate of aluminium with sufficient copper phosphate to give it the proper colour and subjecting the damp precipitate to prolonged hydraulic pressure. However, there is a difference in the hardness and specific gravity between the artificial and natural stones. There is also a distinct difference in the behaviour of the two stones when heated.

Opal

Opal is practically impossible to reproduce artificially owing to the peculiarly beautiful accidental internal structure.

Imitation pearls

Imitation pearls, usually a hollow sphere of opalescent glass, coated inside with a preparation of fish scales and filled with wax, are easily identified. The greater hardness of the sham jewel is a convincing test. At the

same time it must be stated that these manufactured articles are sometimes very beautiful and, being more durable, can be worn more frequently than the genuine pearl.

Cultured pearls.

It has been known for some time that it is possible to produce cultured pearls so perfectly as to render them indistinguishable from the natural pearl. The earlier Japanese attempts, by suitably maltreating the oyster, invariably resulted in poorly shaped and deformed pearls which could be readily distinguished by jewellers. The 'Mikimoto pearls,' however, have steadily improved since 1913 (Dr. Lyster Jameson as quoted by the *Daily Telegraph* of the 26th May, 1921). This authority states that "experienced pearl merchants, and indeed, any zoologist who is familiar with the shells of the different species and geographical races of pearl and mother-of-pearl oysters, can usually distinguish pearls from the Japanese pearl oyster (*Margaritifera Martensii*) from pearls from other species, just as they can distinguish Ceylon, Australian, Central American, etc., pearls from each other by slight differences in colour and lustre: but this test only reveals that the pearls come from the Japanese pearl oyster and cannot be used to distinguish naturally and artificially-produced Japanese pearls from each other:....This natural difference is greatly intensified when the pearls are examined in ultra-violet light.....When examined with polarized light between crossed Nicols, the section of a natural pearl, of course, shows throughout the *cross* of extinction characteristic of concentrically crystallized bodies ....A section of a Mikimoto pearl, on the other hand, shows the *four arms* of *the cross* in the outer part...." In "The *Jewellers and Watchmakers Trade Advertiser*, Volume XXXI of May 1921" various members of the diamond, pearl and precious stone trade section of the London Chamber of Commerce claim to be able to distinguish the cultured Japanese pearl from natural pearls of other localities. Much perturbation has been caused by the production of very excellent cultured pearls, and the buying public are uncertain whether these pearls are genuine or not. Professor Nishikawa of the Imperial University of Tokyo brought some of his so-called cultured pearls to the Geological Survey Office, Calcutta, for opinion. It is the opinion of a well known firm of jewellers in Calcutta that these pearls have an 'egg shelly.' surface and lack the sheen of natural pearls. In the writer's opinion they are real pearls

and, short of destroying the pearl for microscopic examination between crossed Nicols, there appear to be no tests to indicate whether the oyster produced the pearl as a result of natural causes or was irritated into performing the same task.

CYRIL S. FOX

MANUFACTURE IN GOVERNMENT ORDNANCE FACTORIES OF WAR MUNITIONS IN INDIA

BY

Major-General L. R. KENYON, C.B.
Director General of Ordnance in India

In the following note a brief account is given of the position of the Government Ordnance Services as regards obtaining some of their more important and immediate requirements for the manufacture of war munitions in India. It is the accepted policy that Indian material should be used in preference to imported material, if quality and price are suitable.

Cordite

The necessary materials for cordite are nitrate of soda, sulphur, acetone, glycerine, mineral jelly and cotton waste. Nitric and sulphuric acid are made from these and then nitro-glycerine and nitrocellulose. Of these materials, cotton waste has been obtained in India for a number of years past. The only real test for the suitability of samples of mineral jelly and of glycerine is to work them up into cordite and to see that the resultant cordite shows standard keeping qualities. During the war, a good many samples of Indian made mineral jelly were tried, but the results were not very satisfactory. A sample from the Straits Settlements refinery of the Asiatic Petroleum Company, however, did well, and the Research Department at Woolwich considered that it would probably prove satisfactory. The Superintendent, Cordite Factory, Aruvankadu, is therefore, trying to obtain more of this mineral jelly with a view to making up one or two trial batches of cordite which will be kept under special observation.

Mineral jelly

Glycerine should be obtainable from soap works, but at present it is found necessary to import it into India. The Superintendent, Cordite Factory, has entered into correspondence with the Hind Candle Works, Bombay, to see whether their glycerine will prove satisfactory.

Glycerine

An experimental nitration on a manufacturing scale, for which about 1,000 lb. of glycerine is necessary, is the only conclusive test. It is essential that the nitro-glycerine produced on nitration should separate quickly and completely from the mixed acids.

Sulphur

Sulphur has to be imported, usually from Italy or Japan. This, of course, is not satisfactory from the military point of view, but the only potential source of sulphur in India appears to be zinc sulphide ores in Burma and these are not smelted in India. Until this is done, India cannot be independent as regards its supplies of sulphuric acid.

Nitrate of soda

Nitrate of soda is required for making nitric acid, and its ultimate source of supply is, at present, Chili, though supplies required by the Cordite Factory are obtained through England. This source of supply will have to be relied upon until some system of fixation of nitrogen from the air is developed in India, and this, in its turn, depends upon the development of hydro-electric plants to supply the necessary cheap power.

Acetone

The Government Factory at Nasik has shown that acetone can be made in India, but the demand for this material is very limited, so that the economical running of this factory is a difficult problem. During the war, a different propellant from cordite had to be developed in England which depended upon ether and alcohol for its preparation instead of acetone, but at present, at any rate, there is no immediate likelihood of India abandoning cordite.

Chemical pottery

Besides the raw or semi-manufactured materials required for cordite, it is desired to obtain in India the chemical pottery and materials used to construct the acid chambers, gun-cotton plant, etc. We have had to obtain our large lead sheets for the sulphuric acid chambers from England in the past, and this also entails keeping larger reserves of materials in hand than if these materials were made in India. The Industrial Handbook of 1919 showed that lead sheets of the required degree of purity could be produced in India, and the Superintendent, Cordite Factory, has entered into correspondence with Messrs. Octavius Steel and Co., Managing Agents of Venesta Limited, to see whether they cannot supply the lead sheets which the factory requires. Generally speaking,

Lead sheets

it may be said that for sulphuric acid chambers large sheets (*e.g.*, 20′×8′×½″) are required. Chemical pottery and stoneware acid-resisting bricks, etc., are required for the Cordite Factory, which makes its own nitric and sulphuric acids. This factory is trying the products of the Perfect Pottery Company, Jubbulpore.

High explosives

Trinitro-toluol

For high explosives the Army must depend on picric acid (lyddite) or on T. N. T., or on T. N. T. combined with ammonium nitrate. At present all these are imported, but there is no physical reason why they should not all be made from raw materials available in India. From the military and economical point of view, it is desired to adopt the combination of T. N. T. and ammonium nitrate known as '80-20 amatol' (*i.e.*, 80 parts of ammonium nitrate to 20 parts of T. N. T.). The T. N. T. must be of a high degree of purity in order to avoid exudation. For the manufacture of ammonium

Ammonium nitrate

nitrate, it has already been pointed out that the development of hydro-electric plants with a view to the fixation of atmospheric nitrogen is a necessity.

It is believed that T. N. T. is easier and cheaper to make than picric acid, so that it would be preferable now to develop the former instead of the latter. Dr. E. R. Watson, M.A., D.Sc., Principal of the Research Institute, United Provinces, Cawnpore, has recently drawn the attention of the Ordnance Department to a method which he has worked out and patented for obtaining T. N. T. from Assam petroleum. This method has been referred for opinion to the home authorities as well as to the Ordnance experts in India. It is understood that Messrs. Waldie & Co. have given some attention to the possibilities of producing picric acid or T. N. T. in India.

Electric insulators

Satisfactory samples of electric insulators have been received from Bengal companies by the ordnance factories. As soon as requirements are standardized it is hoped to get the necessary moulds made by local firms and to buy all requirements from them.

Metals

As regards metals, the ordnance factories have for some years past obtained their lead from Burma and their tin from Burma or the Malay States. Antimonial lead, with 15 to 16 per cent. antimony, is required for bullets and is obtained from Burma.

Lead
Tin

The ordnance factories are just about to try on a manufacturing scale some of the Cape Copper Company's copper from Singhbhum. Hitherto all copper has been imported. A sample of this Indian copper has been examined on a small scale in England and it is believed that it will be suitable for cartridge making, but a very pure electrolytic copper is essential for this purpose: the brass made from it has to be punched and drawn into cartridges, and if any flaws or internal stresses are left in the cartridge a blow back may ensue which may put the gun or rifle, or the man himself, out of action. If the metal is left too soft it will expand on firing and jam in the gun.

Copper

Nickel

Nickel is not obtainable in India.

Zinc is all imported, but should be obtainable from the zinc ores in Burma. It will be seen, therefore, that the smelting of these ores in India is very important from the military point of view, as on these ores depends the chance of obtaining both zinc and sulphur.

Zinc

Eighty per cent. of ordnance factory requirements of ferro-manganese is obtained from the Bengal Iron and Steel Company, Kulti. This ferro-manganese is quite suitable for shell steel and merchant steel, but is rather high in phosphorus for certain gun and rifle steels which call for phosphorus in the finished article of under 0·04 per cent. For these steels we import ferro-manganese with a maximum phosphorus limit of 0·1 per cent.

Ferro-manganese

The supply of aluminium in India must depend upon the development of hydro-electric plants for the smelting of the plentiful bauxite ores.

Aluminium

Refractory materials

As regards refractory materials, ground ganister silica dust supplied by Messrs. Burn & Co. and by Messrs. Bird & Co. has proved as suitable as English ganister for the acid steel furnaces of the Metal

and Steel Factory at Ichapore. The following are the analyses of two consignments, but fusion tests are more satisfactory than chemical ores in many ways:—

	No. 1	No. 2
SiO_2	87·0	87·6
Fe_2O_3	4·14	2·57
Al_2O_3	4·36	7·03
CaO	0·76	0·61
MgO	Trace	0·20
Loss on ignition	3·20	1·85
Alkali (difference)	0·54	0·14

For the basic furnace at the same factory, light calcined magnesia has been obtained from the Magnesite Syndicate, Ltd., Salem. It has been calcined to 'deadburnt' at Ichapore, and the Metal and Steel Factory has supplied some of this material to the Perfect Pottery Company at Jubbulpore, and it is hoped that this Company will be successful in making the necessary magnesite bricks. The magnesite itself is quite good. An analysis of this magnesite is as follows:

Residue in HCl.	2·93
Fe_2O_3 and Al_2O_3	0·42
CaO	2·10
MgO	73·99
Loss as CO_2	20·56

Local fireclays have been obtainable in the neighbourhood of each ordnance factory suitable for their requirements.

Wood

Walnut wood is always used for the stocks of rifles. In the past they have been imported from Europe, already cut up in the rough. The Rifle Factory, Ichapore, however, obtained some stocks in 1918-19 from the Deputy Conservator of Forests, Hazara, and workshops and the necessary steaming plant have been installed at Jaba near Abbottabad, Hazara, and also at Baramulla. Experts have been sent from the Rifle Factory to Jaba and Baramu'la to assist the local officers in selecting the trees and in sawing them up and marking out. There is little doubt but that the wood is of the right quality, and only organization on the spot i nec ssary and subsequently careful seasoning.

General

In the above notes only a few of the chief requirements of the ordnance factories have been dealt with, and a brief sketch given of some of the steps taken to use India's raw materials in lieu of imported materials. There are, of course, very many other stores used by the ordnance factories, and, as has been stated above, the approved policy is to use Indian stores whenever these are of suitable quality and can be obtained at reasonable prices.

If any of our readers wish to make further enquiries, it is suggested that they should communicate with one or other of the following officers—

The Director General of Ordnance, Simla, on general subjects and principles.

The Director of Ordnance Factories, 6 Esplanade East, Calcutta.

The Superintendents of any of the Ordnance Factories, which are as follows:

Metal and Steel Factory, Ichapore, Nawabganj, Bengal.
Rifle Factory, Ichapore, Nawabganj, Bengal.
Gun and Shell Factory, Cossipore, Calcutta.
Ammunition Factory, Dum-Dum, Calcutta.
Gun Carriage Factory, Jubbulpore, Central Provinces.
Harness and Saddlery Factory, Cawnpore, United Provinces.
Ammunition Factory, Kirkee.
Cordite Factory, Aruvankadu, Nilgiris, South India.

L. R. KENYON

THE MANUFACTURE OF GLASS WITH INDIGENOUS ALKALI

BY

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The fact that all over the world, and particularly in hot countries, an efflorescence of saline matter is found to occur on some tracts of land is quite well known. The nature and composition of these incrustations vary very widely. Some are composed nearly wholely of nitre (potassium nitrate), some of soda carbonate, whilst others have soda sulphate, sodium chloride or other salts of the alkali metals as their chief constituents. It is very seldom that only one salt is present, though in a majority of cases one constituent predominates over all others.

The nitre-bearing efflorescence is known in India as '*shora*' and is used for the manufacture of nitre crystals. This industry is fully established in this country and large quantities of nitre or saltpetre are exported every year to Europe. The efflorescence consisting chiefly of sodium sulphate is called '*khar*.' This is only partially refined for use in the wet curing of hides. No pure sodium sulphate is made from it, as the imported article usually works out cheaper than what it costs to produce the indigenous material; and, moreover, there is not much domestic consumption of Glauber's salt or sodium sulphate. The deposit in which sodium carbonate predominates is known as '*reh*' or '*sajji-matti*.'

In this paper it is proposed to show that *sajji-matti*, when refined, gives an 'alkali' quite suitable for glass-making, and that the cost of production of this is at any time much less than the prevailing price of imported soda ash, which is at present exclusively used by glass makers in India.

The tracts of land which give *sajji* are, in general, uncultivable and so are of very little agricultural value.

The efflioresence begins to form as soon as the rains are over and is collected between March and May. Whatever is not collected before the rains set in is washed away and lost.

Manufacture of crude alkali

The process by which the *Lunias*—a class of men whose chief occupation is the production and sale of *sajji*, *shora*, etc.,—manufacture crude alkali is as follows. The salt-bearing earth is scraped to a depth of from half an inch to one inch by means of bamboo sticks and the earthy stuff is collected in heaps. At convenient places (generally one in each *sajji*-bearing village) small, crude refineries are built and all the scrapings are brought to these, where they are partially refined to a product called *sajji* which is carted to towns.

The refinery put up by the *Lunias* consists of a crude filter-mound and a number of shallow evaporating beds. The filter-mound is made by erecting two parallel walls of mud about 4 feet high, 10 feet to 20 feet long and about 2 feet to 3 feet apart from each other. About two feet from ground level a bed of twigs and rafters is constructed in the channel between the walls, a layer of straw is spread on the twigs which is followed by a layer of gravel, and, lastly, there is a layer of sand. The evaporating beds are shallow masonry tanks of fairly large dimensions.

The scrapings brought from the fields are spread on the layer of sand in the filter-mound to form an even bed from 9 inches to a foot deep and water is poured over this. As a result of percolation the soluble salts are dissolved, and the solution coming out at the bottom of the filter-mound is led by channels into the evaporating beds where most of the water evaporates by solar heat, leaving the moist soluble salts together with some mechanically carried impurities. The evaporating beds are scraped when a sufficiently thick deposit has been formed and these scrapings form the *sajji* of the market.

The initial cost of an ordinary sized factory is about four to five hundred rupees, the masonry evaporating beds taking up the major portion of this amount. The cost of the evaporating beds—which is a recurring item, as the beds last only one season—plays an important part in the cost of finished *sajji*, and so, if the yield of an evaporating bed can be increased, the cost of *sajji* will be correspondingly diminished. A material acceleration in the rate of eva-

poration can be effected by taking as much concentrated solution into these evaporating beds as possible. A very practical way of doing this is by allowing the weak solution from the filter-bed to trickle over ricks of brushwood so arranged that the solution is fully exposed to the prevailing winds. This will entail labour in bringing the solution to the top of the ricks, but we have found that this extra cost is more than compensated by the increased production of the factory.

Analyses of *sajji*.

We have analysed more than 500 samples of *sajji* from different localities all over India. The following seven results of analysis will give a fair idea of the composition of an average sample of *sajji* :—

—	1	2	3	4	5	6	7
	Per cent.	Per cent.	Per cent	Per cent.	Per cent.	Per cent.	Per cent.
Insolubles . .	5·1	7·2	3·3	4·3	4·2	6·5	8·4
Na_2CO_3 . .	56·1	52·3	53·4	48·2	60·2	54·2	48·6
Na Cl . . .	0·2	3·8	4·3	2·6	0·4	1·2	3·2
Na_2SO_4 . .	2·6	1·2	1·8	6·3	4·3	0·3	7·2
Moisture . .	35·6	35·2	36·0	38·2	30·3	37·3	31·4
	(together with a small quantity of organic matter.)						

The moist substance as generally sold is of a dark brown colour, the colour being due to the presence of organic matter which may be burnt away by a process of roasting.

From the above analyses it will be seen that it is not impossible to find *sajji* which does not contain NaCl in appreciable quantities, *e.g.*, samples 1 and 5. As a matter of fact, such *sajji* can be had in any quantity if care is taken in selecting deposits, and we have invariably used such stuff. The process of manufacture with a view to convert this *sajji* into an alkali suitable for use in glass making is as follows.

The *sajji* is roasted in a specially constructed reverberatory furnace at a temperature of about 800°C whereby moisture is completely removed and organic matter is burnt away. The stuff that

comes out of the furnace is greyish white in colour and contains on an average about 80 to 85 per cent. of sodium carbonate. This 'crude soda' has been purified on a commercial scale to give soda ash containing 90—95 per cent. Na_2CO_3, and very good and readily saleable soda crystals were also obtained by lixiviating the powdered 'crude soda' with hot water to give a liquor of 24° to 28° Tw, allowing the whole to stand hot for about an hour and then either concentrating the liquor to crystallizing point and leaving the solution to crystallize or evaporating the clear solution till nearly the whole of the soda carbonate present has been precipitated. The precipitate is taken out and dried by being stirred and rubbed in pans heated by waste gases from the furnace. During the separation by sedimentation of the soda carbonate all the other soluble impurities are left in the mother liquor. Satisfactory crystallization takes place only during the winter months. It has been found by experience that the best concentration of the liquor during lixiviation at which the insoluble impurities settle out the quickest is between 24° to 28° Tw.

Cost of making glass makers' soda

Sajji contains about 50 per cent. sodium carbonate, and even in these days very large quantities can be bought at about a rupee a maund of 100 lb. In our commercial experimental factory at Cawnpore in one season, and with no special or improved organization, we bought close upon 40,000 maunds of *sajji* delivered at this rate at our factory site. By suitable organization it is possible to get locally in Cawnpore not less than 4 or 5 lakhs of maunds of *sajji* practically free from sodium chloride every year. We were able to collect a large quantity of good-class *sajji* by selecting localities near about Cawnpore, care being taken that efflorescence was free from sodium chloride and by inducing the *Lunias* to work particularly on these by giving them advances and other facilities. More extensive and a better quality of *reh* land exists in the Partabgarh, Banda and Jhansi districts of the United Provinces.

Thus, the price of 100 lb. of soda carbonate contained in *sajji* comes to Rs. 2. The roasting of *sajji* to what we have called 'glass-makers' soda' (containing 80 to 85 per cent. of Na_2CO_3) takes 100 maunds of coal per 200 maunds of *sajji* treated. Eight men, including one fireman and a poker, will be able to roast about 200 maunds of *sajji* a day. The wages of these men will be about

Rs. 6 per day. Building the necessary furnaces, chimney, etc., for a factory producing 100 maunds of 'glass-makers' soda' a day will be about Rs. 20,000, Rs. 5,000 being for furnaces and Rs. 15,000 for the chimney and other buildings. Taking the life of a furnace to be three years, the daily charge on account of depreciation comes to :—

	Rs.
Furnaces	6
Chimney and other buildings at 5 per cent. per annum . .	2
	8

The cost of manufacture of 100 maunds (of 100 lb. each) of glass-makers' soda per day comes to :—

	Rs.
1. Cost of 200 mds. of *sajji*	200
2. Labour (untrained) 8 men	6
3. Labour trained	5
4. Supervision and other overhead charges	10
5. Non-productive menial staff (chowkidars, peons ,etc.) . .	4
6. Cost of 4 tons of coal at Rs. 16 per ton	64
7. Depreciation and repairs	10
8. Unforeseen charges and to round off	21
	320

The cost of manufacture of 100 maunds (of 100 lb. each) of "glass-makers' soda' comes to Rs. 320 and one cwt. of 'glass-maker's soda' will cost Rs. 3-10.

'Glass-makers' soda' as such, without any further purification, can be made to give glass for ordinary purposes quite as good as that obtained by using imported soda, for which the present and pre-war market rates for Firozabad and Shikohabad are Rs. 8 and Rs. 5-8 per cwt., respectively.

It should be noted that the price of Rs. 3-10 arrived at above per 100 lb. of 'glass-makers' soda' is not for 100 lb. of 80—85 per cent. stuff, but for an equivalent quantity containing 100 lb. of pure Na_2CO_3. Even if the imported soda comes down to pre-war price, a clear saving of Rs. 1-8 per cwt. can be effected by using indigenous alkali.

Glass-making with indigenous soda

The following figures give an idea of the quantities and prices of the various substances which enter into the composition of ordinary soda lime glass which is commonly made in India :—

	Rs.
Sand, 200 cwt. at 8 annas a cwt.	100
Soda ash, (English) 100 cwt. at Rs. 8 a cwt.	800
Lime 20 cwt. at Rs. 2 a cwt.	40
Decolourizer, etc. . . . . say	60
	1,000
Coal to melt above into block glass, 13 tons at Rs 16 a ton .	208
Total cost of producing 300 cwt. of block glass (excluding labour, supervision, depreciation, interest, etc., etc.) .	1,208

or Rs. 4 per cwt. approximately.

It will be seen that the two main items of cost are soda ash and coal, the former being fully double the total of all other items. A reduction in the cost of soda will very materially reduce the price of glass. Assuming that indigenous soda can be had for Rs. 4 a cwt., the cost of alkali required for the batch will be Rs. 400 instead of Rs. 800, and so 300 cwt. of glass will cost Rs. 800 instead of Rs. 1,200 as heretofore. In other words, the cost of block glass will be brought down to Rs. 2-10-8 per cwt.

Experimental

(1) Samples of 'indigenous soda' obtained from ordinary *sajji* containing sodium chloride and sodium sulphate in addition to soda carbonate were tried in a glass 'batch.' A little while after the complete fusion of the mass a saline layer came up on the top, giving off a gas (which was found to be SO_2). The mass spurted badly and the introduction of a little water or a piece of cold metal caused an explosion. Even in cases where no foreign matter, like water or metal, was introduced the pots broke in several cases. These experiments were done in a direct-fired furnace of which the temperature was about 700°C and the glass obtained was very poor and opalescent.

(2) In another set of experiments 'indigenous soda' containing soda carbonate and sodium chloride, but practically no sulphate,

was tried. A layer of fused saline matter, similar to that used in the experiments of series No. (1) described above, was obtained but no gas was given off. Spurting and other objectionable features remained the same as before.

(3) In a third set of experiments 'indigenous soda' containing only soda carbonate and soda sulphate was used. A layer of saline mass, as in the previous sets, was formed, but on continued heating it diminished in bulk and after a very long heating disappeared completely. All this time SO_2 was evolved. After the disappearance of the layer of molten saline matter the melt in the pots was more stable and not susceptible to explode so very easily. But even after this stage was attained, the glass obtained, though decidedly better than that obtained from the two previous sets of experiments, was not quite as good as that obtained by using imported soda ash and was nearly always more or less translucent.

(4) The experiments of series (1), (2) and (3) were then made in a gas-fired furnace with a temperature of about 1100°C. No very marked improvement was observed in sets parallel to (1) and (2) but a much superior stuff (and in a period of time nearly similar to that taken by an imported soda 'batch') was obtained in the set parallel to (3) but even in these cases the glass was not quite clear.

(5) To facilitate the decomposition of the sulphate, a quantity of powdered charcoal, equivalent to 10 per cent. of the calculated quantity of sodium sulphate present in the 'crude soda,' was mixed with the batches, and the meltings were done in a gas-fired furnace (temperature about 1100°C). The glass obtained was quite good and in no way inferior to glass obtained from 'indigenous soda' containing no sulphate or chloride.

(6) Glass of a number of deep colours (blue, green, amber) was turned out in the above manner and was found to be quite suitable for bangle making, for which very large quantities of coloured glass are made at Firozabad and neighbouring places.

Conclusion

A glass quite suitable for bangle making and other not particularly fine purposes can be made by using alkali manufactured from *reh* in place of imported soda ash. The cost of manufacture of this glass will always be about 30 per cent. cheaper than when

imported soda ash is used. The only precaution that has to be taken is that only such tracts of land are to be exploited for *reh* which contain no sodium chloride and, as has been mentioned, it is not at all difficult to find large and extensive tracts of this description.

J. P. SRIVASTAVA

D. SINHA

SHIP BUILDING IN INDIA

BY

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India is not contributing her fair share of the world's ship construction, and the little that is being done in the way of wood ship construction is being done along such wrong lines as to make such vessels but poor profit-earning propositions. Even big European companies in India have constructed wood sailing ships only to find, on completion, that the vessels are no good to them.

For commercial purposes the most attractive feature of a vessel is her profit-earning ability, when capital and maintenance expenditure and depreciation of her value have been considered. A great desideratum is that she should be able to carry a maximum of cargo on a minimum of registered tonnage, as all dues are paid on this tonnage. The Panama and Suez Canal tonnages are slightly different, but a low British registered tonnage means a proportionate privilege on the other tonnages.

It is not generally understood that in the interest of safety of life at sea all vessels over 150 tons burthen must, by international agreement, be surveyed for strength, proper maintenance, and general sea-worthiness, and that all nations have agreed to similar standards of strength. Everyone knows that a long span of a steel bridge must be made of stronger parts than those for a short span, but ship builders, whose products must be prepared to be badly tossed about at sea in bad weather, are not so alert on these points. The strength of a chain does not exceed that of its weakest link and the strength of a ship does not exceed that of its weakest part, so that it is absurdly costly to build vessels very strong in parts and weak in other parts, or with strong parts weakly joined together. It is also a fact that making any two parts of a rigid structure overstrong weakens the intermediate part. The writer has come across no instance of an Indian-built sea-going vessel that has not badly

abused the above points and whose earning capacity has not been heavily handicapped throughout her existence in consequence.

The Government of India, becoming aware of some of these facts, authorized the writer, through the Director of Industries, Bengal, to build models shewing the shipbuilders of Chittagong how ships can best be built to take full advantage of existing laws.

Broadly speaking, cargo-carrying vessels may be divided into three classes, *viz.*:

(1) Those propelled by mechanism only.
(2) Those propelled partly by mechanism and partly by sail.
(3) Those propelled entirely by sail.

An examination of freeboard tables shews that the standards of strength laid down favour approximately:—

Class (1).—When length is twelve times depth.
Class (2).—When length is eleven times depth.
Class (3).—When length is ten times depth.

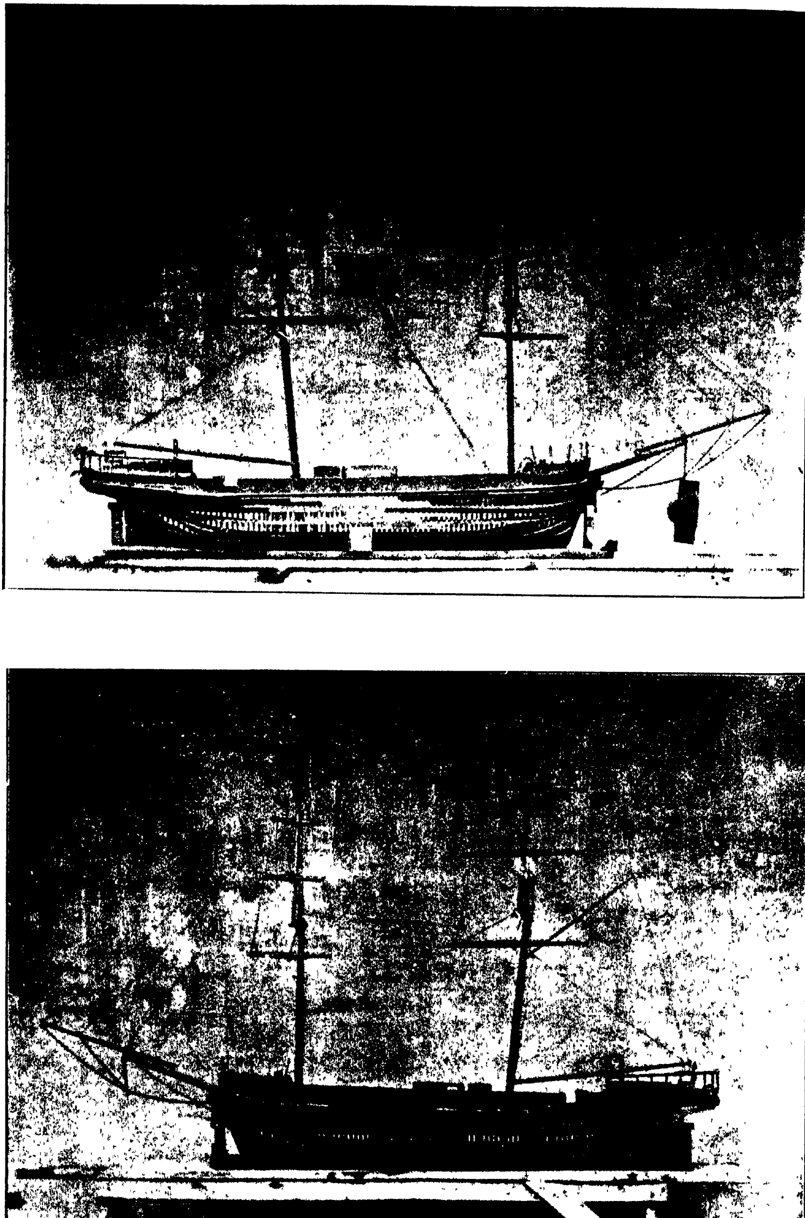
The breadth is equally fixed for the maximum advantage of load line (carrying capacity) through the freeboard definition of block coefficient. In this connection it is worth noticing that every vessel has several lengths, breadths and depths, each being used for different purposes during the construction and life of the vessel.

If a vessel is not built to table dimensions she is considered a distorted vessel and her allowed carrying capacity is adversely affected. For instance, if she is ten feet longer than the table indicates for her moulded depth her load line is lowered, whilst if she is ten feet shorter than her table length her load line is raised by an amount which is only a small proportion of the amount of cargo space she has lost by her diminished length. The reasons for this are perfectly sound and incontrovertible.

If a vessel is built to table dimensions and with appropriate scantlings (no part being too small for consideration) she is allowed to carry the maximum cargo permitted to any vessel of any nation.

Steel steam ships, if properly constructed, can take advantage of every law and obtain 32 per cent. deduction of gross tonnage (on account of propelling space) for their registered tonnages on which their dues are paid. They can be relied upon to work 10½ months a year if properly maintained.

Steel sailing ships, with auxiliary power in the form of long stroke motor engines and a speed which satisfies the surveyor as



Two views of a sectional model of a properly proportioned sailing ship designed to obtain maximum carrying space.

being not below seven knots an hour, can obtain, if the space given over as propelling space is 13 per cent. of the gross tonnage, a deduction of 32 per cent. from their gross tonnage as registered tonnage. They should be able to work for eleven months in a year and are the most profitable investment possible in the sea-borne carrying trade.

Wooden sailing vessels fitted with auxiliary power as above are entitled to equal privileges with their steel sisters on paper, but such privileges are hard to obtain in practice. For instance, most elaborate precautions are necessary against fire; bigger engines and greater fuel expenditure are necessary to obtain the required speed, because the breadth of the vessel would have to be considerably greater to carry the same cargo as her steel sister and the time spent in overhaul and surveys would considerably lower her average annual number of working days. She would have to be made of best teak wood and have copper fastenings throughout, which would make her cost prohibitive now-a-days. It is true that a third-rate edition of the best is feasible, but such a vessel cannot be trusted to be a big dividend earner and it would, generally speaking, be passed with reluctance.

Wooden sailing ships, propelled by sails only, can be big dividend earners if they keep away from India in the monsoon when they become weather-bound and so idle. There is a margin of profit in them still if ample cargo is forthcoming during the working weather, but Indian-built sailing vessels spoil good cargo through not ceiling their bilges and through allowing the chain locker filth to foul the cargo. This narrows down very considerably the number of shippers who will use these vessels. As, however, Indians will go on building these vessels for their own use, the writer has made a sectional model of an accurately designed and constructed wooden sailing vessel and is assured that no local ship builder will again build a vessel without consulting his office about the general dimensions of the whole and all its parts. A complete translation of the names of all parts of a sailing vessel has been made into workmen's Bengali, so that enquirers will know what to ask for, and the office will know what to give. It is, of course, known amongst all local ship builders that no fee is charged for such information or other help. That such aid is necessary will be seen from the fact that the writer has never known an Indian-built sailing vessel that had not its keel hogged or sagged, which was not either too long or too short, too broad

TRADE SCHOOLS, WITH A DESCRIPTION OF THE GOVERNMENT SCHOOL OF HANDICRAFTS, NAGPUR, CENTRAL PROVINCES

BY

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It is recognized that a country cannot develop industrially without a good supply of trained workmen. A lack of skilled labour is often given by business men as the reason why they do not attempt to manufacture in this country what is now imported. Skilled workers in iron and wood are particularly needed. They are the mainstay, one might almost say the substructure, of any industry. Scarcely any industry can be started without them. To build a factory and fit it up with machines, engine and transmitting gear involves the employment of an army of wood-workers, blacksmiths, fitters and turners; and a certain number of them must always be kept to maintain the factory in working order. These trades demand a greater degree of intelligence in the worker than, probably, most other trades. Such workers must understand and be able to work to drawings; they must be able to read, write and calculate. It is a fact that in England carpenters and joiners are men of such trained intelligence that they are usually selected as works foremen, which means that they are the master builders who are responsible for every detail in the erection of a building from the foundation to the roof. That which has to be done in India by the engineer from Roorkee and Sibpur is done by these men, but they have the advantage over the engineer in that they can not only detect a bad piece of work but can demonstrate practically how the work should be done.

Wood-workers, blacksmiths, fitters and turners being needed in abundance, the next point to study is, how are they to be trained. There are two ways, (1) by apprenticeship to working master carpenters and blacksmiths or by apprenticeship to firms, and (2) by a course in a trade school. In countries where the people have

reached a high standard of living the working master carpenter or blacksmith (usually found in villages) can give an excellent training to apprentices. Both of these craftsmen are called upon at times to execute difficult work, and their ordinary work is of a type that is much superior to anything that is done in villages in India. In this country the village blacksmith spends his whole life in making very crude axles, tyres and the points of harrows and seed-drills. He has no means of drilling a hole, in fact he has never seen a hole drilled; his work is so rough that a punched hole suffices. He knows nothing about stocks and dies and taps and a lot of other tools that his contemporary in England always possesses. The possibility of training skilled iron-workers by means of the Indian village blacksmith must, therefore, be ruled out; indeed all these men themselves need to be taught. Firms usually take apprentices, but apprentices, especially in the first year or two, are not a source of profit, and most firms are prepared to train only a very limited number. Moreover, the number of firms in this country is very limited, so that some other agency must be found to train youths in these trades, and this agency is the trade school.

It has been said by people who seem to speak with authority that good workmen cannot be trained in schools. This depends upon the kind of school and chiefly upon the men in charge. During the war hundreds of thousands of munition workers were trained in schools. They were given short courses of a few weeks. They, of course, learnt only a part of the whole trade, but if the schools could make them so tremendously useful in a few weeks, is it not possible that the schools could make them competent workmen in two or three years? Since the armistice the British Government has trained thousands of men in different trades through the means of schools. Finding it impossible to place out as apprentices all the ex-soldiers who desired to learn a trade, the Government established schools and staffed them with competent instructors, who have, in a few months, trained these ex-soldiers up to the point of being able to earn their living at the trade. When the building trades unions of Great Britain refused to admit a sufficient number of ex-soldiers as apprentices, in spite of the great shortage of houses, the Government threatened to build houses officially. This meant that the ex-soldiers would build the houses for practice supervised and taught by instructors. It is possible, therefore, to train competent workmen in schools, but to do so, the schools

must work somewhat on the lines of a commercial firm. Munition workers have been trained in schools by making munitions: ex-soldiers have been taught hair-dressing in schools by practising on the heads and faces of men who obtained this service free of charge: tailoring, bootmaking and a lot of other trades have been taught to ex-soldiers in schools by enabling them to work under factory conditions and make up articles for sale. This, then, is the first essential condition.

The second condition is that such schools must be properly staffed, and the staff must be properly paid. A good, capable instructor in a building of wattle and daub will turn out better craftsmen than an inferior instructor in a costly building. The quality of the pupils turned out by a school is in direct proportion to the quality of the instructors. The people who think it possible to get something for nothing obviously have a great deal to learn. To staff a trade school with poorly paid men is false economy. It is a gross error and yet a very common one to think that economy is achieved by paying low wages. Take the following example which has been met with in the writer's experience. The machinery of a factory cost for coal, oil and staff, one hundred and fifty rupees per day to keep running. Rent, depreciation and interest on capital outlay cost fifty rupees, bringing the total overhead charges to two hundred rupees per day. Whether the machines turn out any work or not this charge goes on. The daily wage bill of the operatives and coolies, with supervision, was approximately forty rupees. It was found that, by getting in a more intelligent class of operative on better pay, thirty per cent. more work was turned out. The supervising staff and the unskilled labourers were not paid more, so that the daily wage bill was not exceeded by more than ten rupees. Therefore, increasing the total daily cost by a little more than four per cent. resulted in a thirty per cent. increase in the outturn of work. In a trade school the following charges go on whether good or inferior craftsmen are being trained—interest on capital outlay for buildings and plant, upkeep of buildings and plant, depreciation of buildings and plant, scholarships, the cost of materials, the pay of menials—cooks and mates, watchmen and sweepers, office charges, such as the pay of clerks and messengers and the cost of stationery and postage. If you add five or ten per cent. to the total cost by employing superior instructors, and in so

doing improve the technical efficiency of the pupils by fifty per cent., you are exercising a very real economy.

The third necessary condition is to recruit the right type of pupil. He should, preferably, be one of the working castes and should, at least, have passed the upper primary or fourth standard vernacular examination. Youths of the working castes who have passed a higher standard are more suitable, and there is little fear of them not using the training received by taking up clerical work. There is some risk in recruiting youths of the castes that ordinarily do not do manual work, especially if they have been educated up to the fourth or fifth standard in English. But this risk is largely avoided if the school fulfils the first condition and is worked on commercial lines. For instance, when a youth of the writer caste is told to take one end of a pit-saw to get some practice in sawing up a log, if he has no heart in manual work he is absent the next time the roll is called. An ideal trade school in this country would perhaps have only the sons of hereditary craftsmen in its classes, but India's need for more and more producers demands that such schools should be thrown open to youths of all castes.

The fourth essential condition is that pupils in trade schools should be granted subsistence allowances sufficient to make them independent of help from their parents. The cost of training craftsmen, in the present period of the world's history, is becoming more and more a charge on employers or the State. In industrial countries like England apprentices are being paid quite good wages while they learn. This is a reversal of the policy of years ago when apprentices had to pay big premiums, or work without wages or with scarcely any wages, for the whole period of their apprenticeship which was usually seven years. Finding that young men would not submit to being bound for a number of years on low wages, employers had to make apprenticeship more attractive by reducing the length of the period and by providing allowances sufficient to cover the cost of subsistence. Industrialists must have a steady supply of skilled labour, and such labour can be better trained by a system of apprenticeship or by a course in a trade school than by any other means. In India the parents of boys who wish to become artisans are usually too poor to be able to support their sons while they take a course in a trade school. If, therefore, suitable subsistence allowances are not provided by the

school, boys will pick up a trade by precarious means and become indifferent workmen, or they will swell the ranks of non-producers.

II

The School of Handicrafts at Nagpur works on the following lines. There are two courses, one for wood-workers and the other for iron-workers. A minimum educational qualification of the fourth standard vernacular is demanded. Only selected boys of good physique from sixteen to nineteen years of age are admitted. Preference is given to the sons of artisans or to boys of the working castes as being likely to make the best use of the training. Subsistence allowances are granted to all at the rate of eight rupees per mensem for the first year and nine rupees per mensem for the second. At present these are supplemented by a 'dearness allowance' of one rupee eight annas. All boys, except those living with parents or guardians in Nagpur, must live in the hostel under supervision.

It might be wondered why the terms 'wood-workers' and 'iron-workers' are used instead of carpenters and blacksmiths. The reason is that in India there is no specialization as in other countries. A man has to be a carpenter, a joiner, a cabinet maker, a coach builder, a wheelwright and a pattern maker; he should also be able to French polish, varnish or paint his manufactures. In the course for wood-workers all these trades are taught. In the iron-working course boys learn blacksmithing, turning, fitting, screw-cutting and all about oil-engines.

The reason for admitting only such boys as have passed the upper primary examination is that without this training they cannot grasp the principles of geometry and scale and model-drawing, and they cannot understand the lectures.

Two years is rather too short a period for these courses, but the advantages over a longer period are, (*a*) boys will join for two years but a three years' course will keep many bright boys away, (*b*) really bright boys will learn a great deal in two years and it is a pity to keep such boys on a government stipend when firms are anxious to employ them on good wages, (*c*) dull boys who cannot learn sufficient in two years can be given a third year, (*d*) a short course stimulates boys to do their best and to attend regularly because of the existence of a feeling that there is no time to spare.

These advantages, and the great demand there is all over India for skilled workmen, justify the two years' course.

A hostel where the boys will live under the supervision and control of the headmaster is a necessary adjunct to a school in India, not merely for the convenience of the boys but for their physical efficiency. Boys who live in the hostel keep much better health than others who live in their villages. The percentage of attendance in the School of Handicrafts is very high. During the great epidemic of influenza in 1918, when all the schools and colleges in Nagpur had to be closed, the School of Handicrafts was the only one to carry on as usual, and when thousands upon thousands lost their lives all the boys in the hostel of this school were kept free from the disease. This school has carried on as usual when all other schools have been closed for months on account of plague.

The practical training is divided into six stages. The first stage consists of exercises in the use of the tools; the second in making from drawings a complete set of joints in wood-work and a complete set of forging exercises. In a later stage a boy works as an assistant to a second-year boy making up articles of commercial value. Ultimately he becomes number one on a bench, at a forge or on a lathe. Each boy has a personal register which is written up every Saturday, showing the work he has done during the week and marking the stages as they are complete? This record tends to make the boys diligent, as they are partly judged from it at the time of examination. Only diligent boys receive the School's certificate, the possession of which is coveted.

Many employers are not in favour of trade schools. They say that such schools, by reason of their short working day and their easy-going methods, unfit boys for hard work and the long working hours of a factory. Pupils in the School of Handicrafts work the same hours as men in railway workshops, *viz.*, eight and-a-half per diem. They work from 6-30 A.M. till 12 noon in the workshop. At 2 P.M. they are back again after the mid-day meal and bath and they spend from 2 till 5 in the class-rooms. The first hour is taken up with a lecture on materials and processes and taking notes for future reference; the remainder of the afternoon is devoted to drawing. The School attaches great importance to the pupils being able to draw and to understand drawings and the English footnotes on drawings. Particular attention is paid to object sketching, which, in a workman, is a very valuable qualification.

If he can rapidly make a sketch of an article, putting in the dimensions in figures, he can afterwards make a scale-drawing from the sketch. Machine drawing is done from the object and not from a copy or a chart. This demands the exercise of the whole of a boy's intelligence. The boys trace and ferrotype-print their own drawings.

In the workshops there are plaster black-boards on all the walls. On these the boys are taught to sketch an article to be made. One of the most important features of the training given in this school is the method by which a full-size sectional drawing of any work to be constructed is first made on a whitewashed board. From this drawing the size of every part is taken, and every part is marked or 'set out.' This, of course, obviates a lot of measuring and prevents mistakes being made. Each part is put on to the board and marked where it should be mortised or tenoned or dovetailed. If all the parts are marked or 'set out' properly from this drawing they will all fit together correctly. In England all work is constructed by this method, but it is nowhere practised in India except in railway or other large workshops.

Object lessons are a feature of the class-rooms. Such things as mortise rim, cupboard, till and box locks are hung in series on the walls; also hinges-butt, flap, strap, box and others. Objects illustrating the stages in the making of a weld, all the different sections of iron, all the different pipe joints and materials are represented here. Here are wooden models of shafting, a coupling, a clutch, a keyway, a feather and such things. In one class-room is a small oil-engine, raised for facility of demonstration.

The aim of the School being primarily to train village artisans in order to improve the crafts of the countryside, only the use of such tools as an artisan can reasonably be expected to provide for himself is taught. What machines there are in the School—lathes for example—are comparatively inexpensive. To train turners—who are greatly in demand—a school must have lathes. In order that boys may learn not to abuse a lathe by taking too deep a cut or by applying the tool suddenly, they first work a treadle lathe which comes to a standstill when abused in the manner described. There is also a lathe driven by a pulley which is revolved by a handle, and there are two lathes, each with a different arrangement of countershaft driven by a 1½ h. p. oil-engine. This variety of drive has been purposely arranged for educational purposes.

A small hand-power mortising machine is a thing seldom seen in this country. There is one in the School which is much appreciated by the boys when there are a good many stiles of doors or naves of wheels to be mortised. It would pay any small woodwork contractor to obtain one of these machines. Such things as iron planers and milling machines are not to be found in the School; the planing of surfaces is done and cog-wheels are made on a lathe. There is a great variety of hand tools in the School, tools that enable a man to obtain a greater output of accurate work with less physical effort than can be obtained with the tools possessed by the ordinary bazar *maistri*.

The pupils work on benches and not on the floor; the standing position enables them to use their improved tools to advantage and to get through a greater amount of work. It is interesting to record that passed pupils demand a bench to work upon when they take up employment with a contractor whose men work on the floor. They realize the advantage a bench gives them in the matter of output.

One of the most important features of the policy of the School is that all pupils who satisfactorily complete a course of training are given, gratis, a kit of tools. This is done on the principle that it is useless to teach the use of good tools if on leaving the School the pupils will go back to the use of the crude, ineffective tools of the ordinary bazar workman, and that a badly equipped workman cannot be expected to get a good living. These kits of tools also act as a focus for the education of the friends and relatives of passed pupils, many of whom come from and return to remote villages. Most of these tools are made by the boys in the School as part of their training. It is really an essential part of an artisan's training to be able to make his own tools. The iron-working pupils make all their tools including a screw-wrench, a ratchet-brace and a cramp and brace for drilling. The wood-workers make their own planes—trying, jack, smoothing, plough, fillester, bead, ovalo, lambstongue, ogee, hollows and rounds; the metal screw-fittings and the cutters being made by the metal-workers. Saws, of course, are not made by the boys. The manufacture of these tools not only provides the School with plenty of work but it represents a maximum amount of labour for a minimum outlay on materials. In other words, there is not much material in tools but the labour involved is considerable and the workmanship must be very accurate. The

commercial value of this work represents thousands of rupees, as each set of tools would cost now-a-days two hundred rupees to import from England.

The School provides part-time courses for apprentices who work in factories and workshops in Nagpur. The object is to develop the intelligence of these youths by training them in theory, drawing and mensuration.

III

Attached to the School of Handicrafts for convenience of administration is a school for the training of *mochis* (leather-workers). This school works on the principle of learning by making. Boys, youths and men are admitted. No educational qualification is demanded. Pupils are mostly recruited from the local communities of *mochis* who make the rough *desi* shoe. *Mochis* from other districts also attend if they have friends in Nagpur with whom they can live while undergoing the course of training. Christians and Muhamadans who desire to learn the trade are admitted. Some of these live in a separate room of the hostel of the School of Handicrafts. One boy, an educated Christian, became a splendid bootmaker, and there are other Christians who have done exceedingly well.

The working hours are from 8 A.M. till 5 P.M. with half an hour off for the mid-day meal.

The pupils sit around the instructor on the floor. This being a trade that is always practised in the sitting position, the pupils might just as well sit on the floor as on stools, and they prefer the floor. There are benches to be used when designing and cutting out uppers. A light sewing-machine for calf and kid uppers is used and a heavy one for ammunition boot uppers and other heavy work; also a rolling machine for compressing sole leather and a small machine for punching and eyeletting. This roller and several others were made in the School of Handicrafts. The method of designing uppers and working out the correct proportions is taught on a large plaster blackboard.

After the first lessons are given in the various processes of shoemaking, the pupils make hand-sewn shoes of common leather. These shoes find a ready sale with the pupils of the School of Handicrafts. After this the *mochi* pupils get their practice by filling orders for the public. All kinds of high-class footwear are made,

including polo and riding boots.. Orders are received from all parts of India, from Mesopotamia and even from England.

No subsistence allowances are provided for these pupils. From the beginning they earn sufficient to support themselves. The proceeds of the sale of boots and shoes, less the cost of materials, are paid to the pupils who deposit a portion of the money thus earned in the Post Office Savings Bank to help them in their after career.

This school, therefore, does not cost Government anything for scholarships or materials. Working this school partly on commercial lines avoids the criticism of employers that such schools unfit young men to enter factories, and it makes the work more interesting to the pupils besides providing them with an incentive to work hard. A fixed subsistence allowance or scholarship would deprive them of this incentive.

There is now a considerable community of well-trained bootmakers in Nagpur as the School has been working since February 1912.

IV

The School of Handicrafts at Nagpur is the model which has been copied in other districts of this province. There are now three Government and four Government-aided schools which are worked on exactly the same lines. Two more Government schools will be built as soon as funds become available.

It will probably be of interest to explain by what arrangement these aided schools are made to copy the Nagpur model. It is as follows. The school authorities provide buildings, a superintendent, clerical and menial staff and materials; Government provides and pays the instructors, and provides and maintains tools and plant, drawing instruments and drawing materials. At one school, which is attached to the workshops of a commercial firm, the firm provides the subsistence allowances. At another school, which is maintained by a trust fund, the subsistence allowances are provided by Government. In the case of two aided mission schools Government provides subsistence allowances for non-Christians.

It may be mentioned that the technical training classes of the Reformatory School have been reorganized on the model of the Nagpur School.

The instructors provided for aided schools have been trained in the School of Handicrafts, Nagpur. In all the schools, Government as well as aided, there are eighteen of these young men.

E. E. A. COVE

INDUSTRIAL DISPUTES DURING THE SECOND QUARTER OF 1921

The following tables have been prepared upon the same plan as those published in the last number of the Journal. The figures of persons employed and of days lost are again only approximate. It is practically impossible at the present stage to obtain reliable statistics of the number of days lost. In many strikes the workmen do not go back to work in a body on a definite date. They return to work in small numbers, and it sometimes happens that some of those who return in the middle of a strike join the strikers again after a few days' work. In the case of some strikes, also, it is impossible to say that they end on a definite date. The process of ending is a long one. A factory may resume its normal or pre-strike work only after a long period during which the strikers return in small bodies and new hands are engaged to make up the balance. It also happens that factories are reported to have resumed their normal work when the post-strike strength is less than the pre-strike strength.

In calculating the number of days lost it has been assumed that the working week consists of six days, except in the case of jute mills which, by agreement, have been working for only four days per week.

From official information received since the publication of the tables in the last number of the Journal, it appears that the numbers involved in the eleven disputes which occurred in Burma were 11,427 and the lost days approximated 76,500. These figures should, therefore, be amended accordingly.

In the following tables a total of 64 disputes is shown. Information, however, has been received of 31 other disputes, but the information is not yet sufficiently complete to allow these strikes to be included in the tables for the last quarter.

TABLE I

Provinces	Number of disputes	Numbers involved	Days lost	Demands: Pay	Bonus	Personnel	Leave and hours	Others	Not known	Results: Successful	Partially successful	Unsuccessful	Indefinite	Not known	In progress
Bengal . .	17	71,220	9,37,590	12	1	4	.	..	..	1	7	4	3	..	2
Bihar and Orissa	1	100	200	1		.	..	..	..	..	1	..	..	..	..
Bombay .	19	21,118	5,86,608	9		4	1	5	..	3	1	11	1	..	3
Burma .	7	2,830	80,378	6		1	..	..	..	2	..	4	..	1	..
Central Provinces	1	1,070	12,840	..	1	..	..	..	..	..	1	..	..	..	..
Madras . .	10	9,599	95,371	4	..	3	1	1	1	4	..	3	1	..	2
Punjab . .	2	1,300	55,800	2	..	..	..	..	..	..	..	1	..	1	..
United Provinces	7	15,195	3,45,870	2	4	..	..	1	..	1	2	4	..	..	..
TOTAL .	64	1,22,432	21,14,657	36	6	12	2	7	1	11	12	27	5	2	7

TABLE II

Industry	Number of disputes	Numbers involved	Days lost	Demands: Pay	Demands: Bonus	Demands: Personnel	Demands: Leave and hours	Demands: Others	Demands: Not known	Results: Successful	Results: Partially successful	Results: Unsuccessful	Results: Indefinite	Results: Not known	Results: In progress
Cotton mills .	21	26,997	2,55,339	11	2	4	1	3	..	5	2	10	2	..	2
Jute mills . .	5	48,000	1,57,500	2	1	2	..	..	..	1	2	1	1	..	..
Engineering works	5	634	1,610	4	..	..	1	..	..	..	2	2	1	..	..
Railways (including workshops)	7	18,311	7,26,004	1	..	5	..	1	..	..	1	4	..	..	2
Salt mines . .	1	1,000	48,000	1	..	..	..	..	..	..	..	..	..	1	..
Tramways . .	1	316	1,264	1	.	..	..	..	..	..	..	.	..	1	..
Municipal . .	3	387	1,587	3	.	..	..	..	.	1	1	..	1	.	..
Printing presses .	4	840	24,420	2	..	..	..	2	..	..	1	2	..	..	1
Shipping and docks	3	14,073	7 11,622	3	..	..	..	..	..	1	.	..	..	..	2
Tanneries and leather works	2	3,975	1,03,350	..	2	..	..	..	..	..	..	2	..	..	..
Oil works . .	2	1,200	26,400	2	.	..	..	..	.	..	1	1	..	..	..
Ordnance factories	2	5,000	42,550	2	.	..	..	..	..	..	..	2	..	..	..
Miscellaneous .	8	1,690	15,01	4	1	1	..	1	1	3	2	3	..	..	..
TOTAL .	64	1,22 432	21,14,657	36	6	12	2	7	1	11	12	27	5	2	7

TABLE III

—	April	May	June	Whole quarter
Disputes in progress at beginning	13	5	9	13
Fresh disputes begun	21	24	6	51
Disputes ended	19	30	8	57
Disputes in progress at end	15	9	7	7
Numbers affected	91,684	55,656	31,557	1,22,432
Days lost	9,88,833	5,69,495	5,56,329	21,14,657
Results of disputes ended :				
Successful	8	1	2	11
Partially successful	4*	8	...	12
Unsuccessful	6	16	5	27
Indefinite	1	2	2	5
Not known	...	2	...	2

SUMMARIES OF INDUSTRIAL INTELLIGENCE FOR THE QUARTER ENDING 30th JUNE 1921

Assam

Organization of the staff of the Department and appointment of a Board of Industries.—Proposals regarding the organization of the staff of the Department of Industries and the appointment of a Board of Industries are now under consideration of the local Government.

Government Emporium and Central Stores.—The working of this institution during the first three months of its existence has been very satisfactory. Large quantities of cottage products have already been sold. A branch of the Stores Department has been opened in Shillong for the benefit of Khasi weavers.

Peripatetic weaving parties.—A sufficient number of demonstrators has been trained in the Gauhati Weaving School. Two parties will shortly be formed and sent out to work in two districts for the present.

Tanstuffs.—Negotiations are in progress for carrying out experiments on Assam tanstuffs at the Calcutta Research Tannery.

Hydro-electric scheme.—A scheme to utilize two rivers in the neighbourhood of Shillong for generating electric power for lighting and industrial purposes has fairly advanced. Certain influential persons and the Siem of Mylliem are known to be interested in the scheme.

School of Handicrafts, Sylhet.—A site has been acquired at a cost of Rs. 4,330 and the Public Works Department will shortly construct the buildings.

Industrial loan.—A loan of Rs. 8,000 has just been granted to the proprietor of a small oil and flour mill in order to enable him to extend his factory.

K. L. BARUA,
Director of Industries

Bengal

Future policy of the Department.—The most important question dealt with during the quarter under report was the determination of the future policy of the Department. At the conference of the Departments of Agriculture and Industries, convened by the Hon'ble Minister in charge in April last, it was decided that, Bengal being primarily an agricultural province, the attention of the Department should, primarily, be devoted to the organization of such industries as are dependent on the products of the soil or for which raw materials are naturally available.

The line of action suggested was as follows:

(1) to investigate the possibilities of the use of vegetable refuse as fuel in suction gas engines;

(2) to enquire into the possibility of introducing new and improved methods of extraction of oil from oil seeds with the help of the Industrial Chemist;

(3) to put up a scheme for starting a dairy factory in the neighbourhood of Calcutta;

(4) to consider the possibility of starting a demonstration sugar factory—details to await the report of the Sugar Commission;

(5) to enquire into the possibilities and prospects of fruit and vegetable preservation and put up a scheme for a pioneer factory;

(6) to enquire into the possibilities for starting a demonstration bone crushing factory in collaboration with the Agricultural Department and put up a scheme;

(7) to consider the possibility of establishing a pioneer cigar and cigarette factory and put up a scheme;

(8) to make a survey of the chemical resources of Bengal and to encourage the establishment of small chemical factories;

(9) to submit a proposal regarding a hydro-electric survey of the province;

(10) to take up the question of agricultural engineering in consultation with the Director of Agriculture; and

(11) to take up the industrial survey of the province through the Circle Officers of the Department.

The action that has been or is proposed to be taken with regard to this programme of work is as follows:

Dairy factory and cigarette factory.—Definite schemes with estimates of cost for a demonstration dairy factory and a pioneer cigar and cigarette factory are being prepared for submission to Government.

Industrial survey.—The Circle Officers of the Department have been instructed to take up the industrial survey of their respective jurisdictions and to submit their reports before the 30th September next.

Fruit canning factory.- The possibilities for starting a fruit canning factory were considered by the Advisory Board of Industries. It was considered that at present there was neither scope nor necessity for a Government fruit canning factory as the industry was already fairly well established.

Hydro-electric survey.—With regard to the hydro-electric survey, it has been suggested by the Advisory Board that a survey of the Hill Tipperah and the adjoining region which are much nearer than the Himalayan tracts to the possible industrial centres, should be taken up at present. Government have been informed accordingly. A proposal for the appointment of a Joint Committee of the Public Works and Industries Departments to control this survey, has also been put up to Government.

Utilization of animal by-products.—Regarding a bone crushing factory, statistics of the number of animals slaughtered annually in each district and the number which die of natural causes have already been collected. Further definite action in this matter will not be possible until an Industrial Engineer is appointed.

Chemical factories.—A survey of the existing chemical factories of the province has already been made. Further action in the matter will be taken by the Industrial Chemist whose appointment is expected very shortly.

The possibilities for starting a demonstration bell-metal and brassware factory, a banana meal factory, the opening of an industrial museum and the use of vegetable refuses as fuel are receiving the attention of the Department.

Application of the Land Acquisition Act in acquiring factory sites.—To facilitate industrial operations the Board considered that facilities under the Land Acquisition Act should be given for acquiring factory sites and that provision should be made for the

granting of loans to industrialists and for the supply of machinery on the hire-purchase system. Several applications for help in securing lands under the Land Acquisition Act have been received, but nothing could be done as the local Government have decided that no such applications will be entertained until the existing law of land acquisition is amended.

Granting of industrial loans.—Draft rules for the granting of industrial loans and for the purchase of machinery on the hire-purchase system have already been submitted to Government but have not yet been sanctioned. To meet the immediate demands for machinery required by small industrial concerns, another alternative scheme, as a temporary measure, has been submitted to Government. It has been suggested that certain firms would undertake to supply the machinery and implements required on an extended payment system, provided that Government were prepared to guarantee the payment of the instalments when they became due. Such a guarantee would only be given after careful investigation of the conditions of the firm making the application and on the approval of the Advisory Board. This scheme has also not been sanctioned yet.

Industrial banks. The idea of establishing industrial banks as suggested by the Government of India was not approved by the Advisory Board for the present. The Board considered that their schemes referred to above would, if sanctioned, be sufficient to meet the needs of Bengal for some time to come.

Stores purchase organization and draft rules for the purchase of stores.—For the successful establishment and development of further industries in this country, the Board considered that free and unfettered purchase of all Government stores, both by Imperial and Provincial Departments in India, as generally recommended in the majority report of the Stores Committee, should be the fundamental basis of the policy of Government.

Cottage industries.— A study of the reports of the past industrial surveys of the province will show that, with the exception of the mining industries, European mills and workshops and a few Indian enterprises recently started in and around Calcutta and Howrah, there are very few industries in existence in the rest of the province that cannot be classed under the head of cottage industries. Though a little advancement has been made in some of the *mufassal* districts in recent years, practically speaking, the cottage industry

is still the typical industry of Bengal. The reports also show that a good many of the old industries have been extinguished and that the condition of the more important ones which have still survived is somewhat precarious. The ignorance of the workers in using modern labour-saving appliances and devices, and their extreme poverty-stricken condition due to the undue influence of middlemen, militates heavily against the successful evolution of industries beyond unorganized cottage conditions. Steps have been taken by the Department to advertise its existence, scope and possibilities. A note on the *raison d'être* of the Department, printed both in English and the vernacular, was given wide publicity with a view to attract the industrialists to the Department for its advice and help. The Circle Officers of the Department are visiting the centres of industries in their respective jurisdictions in order to acquaint themselves with the conditions obtaining in existing industries, to study their problems and to find out possibilities for starting new or developing existing industries. In collaboration with the Co-operative Department they are also attempting to form industrial societies by organizing cottage workers on co-operative principles for the introduction of suitable labour-saving appliances whenever possible.

Hand-loom weaving and spinning of cotton, silk and woollen goods may be said to be the most important industry of the Province. The Serampore Weaving Institution, weaving classes attached to the district Industrial Schools and the peripatetic instructors of weaving are to some extent meeting the needs of weavers and spinners in training them in up-to-date methods. The practical difficulties of weavers are being attended to on the spot by the Weaving Expert of the Department whose services are readily available. The supply of yarn and the disposal of finished products are also looked after by that officer. Improved hand-loom, spinning wheel and other apparatus are being introduced among the weavers, and arrangements have been made with a manufacturing firm in Calcutta for the manufacture and sale of such apparatus.

Statistics of Indian embroideries have been collected, and an officer of the Department is now making out a scheme for organizing the sale of the products of the industry on commercial lines.

Next to weaving, tanning of hides may be taken as the second important industry of the Province. The Circle Officers of the Department are undergoing a course of training in the Research

Tannery so that they may be able to explain the modern processes of tanning to the village *chamars,* and arrangements have been made for the practical demonstration of improved methods of tanning by the Research Tannery staff, where suitable opportunities are found. Three pamphlets dealing with the proper methods of flaying and curing of hides, instructions to meat sellers and butchers and a hand-book of tanning in English and the vernacular have been printed and given wide circulation through the Circle Officers of the Department.

A *chamars* society, with Babu Rasik Chandra Charmokar, M. L. C. as president has been formed in Kishoreganj, Noakhali. The improved processes explained by the Circle Officer have been appreciated by the *charmokars* and arrangements are being made to give a full demonstration of all the methods of tanning by the staff of the Research Tannery.

Review of the working of the Department.—Advice and assistance have been given to various industrial concerns in the manner indicated below:

(1) In securing wagons for coal through the Coal Transportation Officer.

(2) In organizing a tanning factory and in erecting the machinery.

(3) In securing labour.

(4) In securing markets for locally tanned hides, electric fans, ropes and cordages, jute canvas, dextrine, textile goods, etc.

(5) In arranging for overseas trade through the Director-General of Commercial Intelligence.

(6) In the development of a weaving factory.

(7) In securing the services of experts for button manufacture.

(8) In giving expert opinion on an automatic hand-loom.

(9) In making out an estimate for a spinning mill.

(10) In selecting suitable factory sites.

(11) In arranging for overhauling a button making plant.

(12) In securing concessions in railway freight and the supply of wood for safety matches and in securing factory sites under the Land Acquisition Act.

(13) In examining a scheme for a paper mill.

(14) In preparing estimates of cost for small weaving factories.

(15) In obtaining machinery and telephone connections.

(16) In testing articles of local manufacture (ink, boot polish and vinegar).

A. T. WESTON,
Officiating Director of Industries

Bihar and Orissa

Coal supply.—The industries of the province continue to suffer severely from shortage of coal and inability to procure sufficient wagons for the carriage of their raw materials and finished products. Small concerns, in particular, are carrying on with the greatest difficulty and most of them have to close down from time to time. Until railway facilities can be greatly extended, any real industrial development cannot be expected.

Technical education.—An aided metallurgical school will be opened at Jamshedpur about the 1st November with the object of training young men to take the place of imported labour on the blast and steel furnaces. The Tata Iron and Steel Company cannot at present replace European imported labour entirely, but in view of the recent strike and the great extensions which are taking place at Jamshedpur and will necessitate a great addition to the skilled labour required, it is very necessary that an intermixture of Indians should take place. Even the most intelligent men of the artisan class have proved a failure when tried on the furnaces, and only one or two educated men have proved at all successful. It has been determined, therefore, to adopt the approximate standard of the I.Sc. for entrance to the school. About 50 students will be taken on who will work in 'doubles' on the 'sandwich' system, *i.e.*, the students will be arranged in pairs and one of each pair will work for one week on the furnaces while his fellow is receiving theoretical instruction in the school, their places being reversed in the next week. The length of the course will be at least two, and probably three, years, according as experience may dictate. Mr. Saunders, Professor of Chemistry at the Sibpur College, has been chosen as Principal and will join his new duties on August 1st. The Government of Bihar and Orissa have promised a contribution of one lakh down (given by the Government of India for the purpose) and Rs. 25,000 recurring, on condition that one-third of the places in the school is reserved for youths domiciled in the province, if suitable

candidates present themselves. It is understood that a very large number of qualified candidates have sent in their names, and it should be possible to secure a sufficient number with suitable physique for the work. It is hoped to send abroad one or two of the most promising students who pass out of the school for further training, pending the establishment of the Imperial Metallurgical Research Institute.

Proposals to establish a school of arts and crafts at Patna have been placed before Government with the approval of the Board of Industries, and it is intended in conjunction with it to run a sale depôt for cottage and art industries. It is not anticipated that such a depôt can be run at a profit at Patna. It is proposed, therefore, to float a co-operative society under the patronage of His Excellency Lord Sinha with a capital of Rs. 50,000 raised in shares of Rs. 100 each, with the idea of providing working capital and also of meeting expenses from the interest on the invested surplus. The scheme has been received with enthusiasm, but it remains to be seen whether it will be possible to raise the money required.

Fisheries Department.—Hitherto, since the province of Bihar and Orissa was constituted in 1912, the Department of Fisheries has remained joint. The Director was stationed in Calcutta and was under the direct orders of the Bengal Government. The control of fisheries has now been taken over and placed under the Director of Industries. There is at present no staff, as the only District Fishery Officer, unfortunately, died in April last. Given a proper staff and funds, there appears to be great scope for the development of the fisheries of the east coast. The Chilka Lake already supplies nearly 500 tons of fish annually to the Calcutta market, while large quantities of dried fish and prawns are exported to Madras. Excellent oysters are also available at False Point and other places on the coast and would probably respond to cultivation.

B. A. COLLINS,
Director of Industries

Bombay

Staff.—Dr. A. N. Meldrum, of the Gujarat College, Ahmedabad, returned from leave in June and has resumed charge of the investigations regarding the manufacture of casein. A second proba-

tionary Circle Officer on Rs. ·150—25—200 has been appointed and will receive his training under the officer in charge of the departmental workshops at Dapuri.

Assistant Director, Ahmedabad.—There is still little in the shape of new industrial enterprise to engage the attention of Mr. Bharucha, the Assistant Director resident at Ahmedabad, and a large proportion of the last quarter was spent by him in the headquarters office. At the end of last quarter Mr. Bharucha was engaged in designing a dyeing shed for a small company at Malegaon in the Nasik District. The leading organizers decided, however, some time ago to allow their plans to fall into abeyance as the majority of their shareholders, under the influence of the non-co-operation movement, were opposed to receiving assistance from a Government department. A few days after this decision was made, rioting and loss of life occurred at Malegaon and no further attempt has been made to carry out the scheme for the dyeing shed.

Chemical Research.—Mr. A. J. Turner, Principal of the Victoria Jubilee Technical Institute, who is the Chemical Adviser of the Department in Bombay and has under special investigation the brines at Kharaghoda, gave assistance to the new factory at Kharaghoda which has undertaken the manufacture of refined salt. Difficulty was experienced in drying the refined products sufficiently, and Mr. Turner was able to suggest structural alterations which will provide the additional drying facilities that are required. His assistant, Mr. Koppikar, was resident at Kharaghoda for the greater part of the quarter investigating the discoloration of the local magnesium chloride which occurs when the crystals are fused preparatory to filling the drums in which the material is sold. After several negative results, Mr. Koppikar believes that he has collected sufficient material to enable him to complete the investigation in the laboratory during the rains when the manufacture of magnesium chloride at Kharaghoda ceases.

In the casein investigation attention is now being directed to eliminating as much fat as possible from the milk before the casein is manufactured. The demonstration factory is dependent for its milk supply on an outside source, and the amount of fat in the milk, as received at the factory, is, therefore, not under its control. It is proposed to put the milk supply through a separator once more before utilizing it for the manufacture of casein. An experimental plant, of the nature of a coffee-drying machine, has also been devised

by Mr. Bharucha to enable manufacture of casein to be carried on throughout the monsoon. In the villages all the casein is sun-dried, and little or no manufacture can therefore be carried out during the wet months of the year. Enquiries regarding the marketing arrangements for the improved casein are still in progress.

Dr. Meldrum's assistant, Mr. Gangolli, in addition to investigating the suitability of several sources of water supply for the proposed dyeing shed at Malegaon and making tests for local oil factories, carried on research on castor oil with results which Dr. Meldrum considers to be promising. There is scope at Ahmedabad for improving the local oil industry which is of some importance. A very complete work on the vegetable oil industry of the Bombay Presidency which was prepared last year by Mr. A. F. Yuill, formerly Assistant Controller (Oils and Paints) under the Indian Munitions Board, will be published shortly.

Three scholarships have been awarded by Government to graduates in science for training at the Indian Institute af Science, Bangalore.

Pottery.—The scheme for a demonstration pottery still awaits the development by the Bombay Development Directorate of the area in which it will be located. Another site which is likely to be more quickly developed was investigated but found to be unsuitable for a pottery. Mr. Fern, the Superintendent of the Pottery Section, is now considering what measures are feasible for undertaking production on a semi-commercial scale in the School of Art with the object, not merely of testing the local market for flooring tiles, but also of giving the instruction in the School of Art a more practical character.

Government workshops.—At the departmental workshops, Dapuri, near Poona, alterations are being made in order to provide the necessary facilities for the training of apprentices. It has been found necessary to make better provision for the primary education of the apprentices, and when a full-time schoolmaster has been engaged the arrangements will be remodelled. The following work of an experimental nature is in hand at the workshops:

(1) Manufacture of an improved silk-twisting machine.

(2) Manufacture of a steam distillation plant for the manufacture of *rosha* grass oil.

(3) Manufacture of machinery for button making.

Fisheries.—The steam trawler, *William Carrick*, made her first voyage on the 17th May and returned from her fourth on the 5th June. The catches improved on each voyage. The vessel was then laid up, partly to avoid the break of the monsoon and partly for repair work on the refrigeration plant. When in dock, a fire in the engine room necessitated further work on board, but trawling was finally re-commenced on the 28th June.

Advisory Committee.—Only one meeting of the Advisory Committee was held during the quarter. The chief business discussed was a concession for working the gum-oleo-resin of *boswellia serrata* which is now under the consideration of Government.

Reparation dyes.—A revised price list for the first and second allocations of reparation non-alizarine dyes is now in course of publication. The demand for the reparation dyes has improved, and buyers are apparently beginning to realize that they have the opportunity of buying good quality dyes at very low prices. A third allocation of dyes in common demand is now being prepared in Manchester.

R. D. BELL,
Director of Industries

Burma

Departmental staff.—Proposals for the complete Industries Department have been submitted to Government and provide for the following superior staff:

One Director.
One Deputy Director, Intelligence Officer and Headquarters Assistant.
One Field Deputy Director for Industrial Survey and Cottage Industries.
One Deputy Director for Labour.
One Assistant Director for Inland Trade Registration, Library and Routine work.
One Industrial Engineer.
One Assistant Engineer.
One Chief Chemist.
Five Circle Officers.
Three Provincial Service Experts in Weaving, Pottery and Lacquer.

Technical Institute.—The Government is now considering the establishment of a technical institute in Rangoon which is designed to absorb the Insein Engineering School, and at the same time to train artisans for all requirements in Burma. In order to estimate roughly the amount of accommodation required, the Director of Industries has addressed a letter to all mill-owners, engineering firms, dockyard and steamer companies, railways (mines, light and tramways), motor shops, chemical works, saw mills, etc., asking them to give him the approximate number of artisans whom they can absorb annually as metal turners, fitters, engine shop-men, moulders, pattern makers, electricians (wiring, etc.), civil engineers, building overseers, plumbers and sanitary fitters, etc., chemical works assistants, etc., and draughtsmen (mechanical, architectural building, etc.).

Sales Depôt.—In order to make the Sales Depôt of Burma art and craft ware widely known to cottage workers, notices in English and Burmese have been circulated through District Officers. It is hoped that this measure will help the art and craft workers of Burma to seek the aid of the Department in finding a wider market for their produce.

British Empire Exhibition.—The Government of Burma have decided to participate in this Exhibition. A Committee has been constituted under the presidency of the Director of Industries to decide all matters relating to the manner in which Burma exhibits should be displayed at the Exhibition. Two meetings of the Committee were held in June.

Museum.—Burma has not yet had a provincial museum worthy of the name, though there has been a considerable amount of material stored in the Secretariat and called the Phayre Museum. Proposals have now been submitted to Government to constitute a general committee to govern the museum. Exhibits are being collected and existing material transferred to a room adjoining the Director of Industries' office, and the different galleries are being arranged and superintended by officers interested. Government has been asked to sanction a staff including a practical taxidermist as curator.

Industrial survey.—The position regarding the industrial survey of the province has not materially altered since April last. Only one circle officer has yet been appointed and he will shortly be required for other work. The Director of Industries is visiting the headquarters of each division in turn to find out, in consultation

with Divisional Commissioners, the industrial possibilities and requirements of their divisions.

Trade registration.—The Director of Industries has made some proposals regarding inland trade registration, but the details are not complete.

Employment bureau.—At the instance of the Government, the Director of Industries is drafting a scheme for the maintenance of registers of candidates for industrial, commercial and other employment. He has also been asked to recommend the best way in which to give publicity to the scheme and to permit likely employers to have access to the records.

Exhibition of cottage industries.—At the forthcoming provincial agricultural and co-operative conference to be held at Mandalay from the 30th August to the 2nd September 1921 it is proposed to hold an exhibition of Burmese cottage industries and instruments and implements that are useful in the making of them. The organization of this exhibition has been undertaken on this occasion by a sub-committee of the Conference Committee. Future exhibitions of the kind will be organized by the Industries Department which is expected shortly to have its full staff of circle officers.

Geological Survey.—Mr. G. de P. Cotter, Superintendent, Geological Survey of India, has arrived in Rangoon where he will recess, and has been accommodated temporarily in the office of the Director of Industries. It is proposed to provide permanent quarters with laboratories for the party in the combined museum and technical institute to be erected in Rangoon.

Site for Provincial Museum and Technical Institute.—In connection with the Development Trust, Mr. Lanchester, Town Planning Expert, has visited Rangoon and has drawn up plans which have now been approved by the various Departments concerned. These plans include the provision of a fine site of 55 acres for the Provincial Museum and Technical Institute mentioned above. The site is centrally situated, a few hundred yards north of the main Rangoon railway station, and is almost equi-distant from all three sides of the horse-shoe shaped river fronts of Rangoon where are the industrial areas.

New port scheme for Rangoon.—The plans provide for the acquisition of over 1900 acres at Dawbon, whereon docks, warehouses and storage godowns and areas will be built with direct railway connection, all intended primarily for ocean-going traffic. The ex-

isting port accommodation will be still available for the coasting, Indian, Straits and Far East shipping and for riverine traffic. The main issue is the provision of docks at Dawbon—the peninsula lying between the Pazundaung Creek and the Pegu River. A short channel from the deep water and the south-east corner of this quadrilateral will lead to the entrance to the dock, a lock of 750 feet by 80 or 100 feet in width. This will accommodate the largest vessels likely to visit Rangoon. By the side of the entrance lock will be a dry dock which has long been recognized as a necessity for Rangoon, and which can, if necessary, be utilized as an emergency entrance. Beyond the lock are two basins with 15 berths (5 for import and 10 for export) with ground for extension to 7 basins, giving 48 berths in all. There will be direct railway communication into the docks together with lines of godowns and storage plots on each side of the railway tracks. Access to the Peninsula over the Pazundaung Creek will be by a broad carriage and motor road carried by a 100 foot bridge at the end of Rowett Street. This new port will enable vessels of draft up to 35 feet to pass into dock at any stage of the tide without crossing the Hastings Shoal. There is also a proposal to recover gradually the ground lost by erosion at King's Bank, which will have the effect of narrowing the river at that point and should thereby result in the deepening of the Monkey Point Channel.

Special enquiries.—In connection with the census the Government has decided to undertake a special intensive study of the social, economic and industrial conditions in two selected districts of Burma, one in Upper Burma (Mandalay), and one in Lower Burma (Myaungmya) and also a special study of the conditions in three selected Burma industries, namely, rice, rubber and mining. Three officers are being placed on special duty, one for Mandalay District, one for Myaungmya District and one for the three selected industries. General instructions for these officers have been drawn up by the Director of Industries and application has been made for the necessary staff. Much of the staff will eventually come under the Labour Section of the Industries Department. The special enquiries of these officers are being co-ordinated with the wages census, census of production, and certain special enquiries undertaken by the census staff at the instance of the Industries Department. The cost of living index will also be worked out by them for certain selected occupations. The enquiry has been limited to wage and

salary earners earning Rs. 200 per mensem and under, and in the district enquiries the number of standard occupations to be investigated has been limited to ten. The enquiry is expected to last upwards of a year.

Labour.—A number of strikes occurred during the quarter. The principal strikes were those of the Burma railway employees, first of the Insein Workshop men, and later of the traffic menials throughout the line. These have now all been settled and there has been no fresh strike in June.

H. B. HOLME,
Director of Industries

Central Provinces

Technical education.—Certain industrial projects, including the provision of two new schools of handicrafts, which were to have been undertaken this year, have had to be postponed owing to the prior claims of famine relief consequent upon crop failure. One new industrial school will, however, be opened at Akola in October next. Progress has been made in existing branches of the Department, notably that of the Textile Expert. The popularity of the improved fly-shuttle sley introduced by this officer continues to increase. This is borne out by the sale figures, 469 sleys having been sold during the quarter under report as against a figure of 350 for the corresponding quarter last year. Applications are continually being received from all over the province asking that demonstrations in improved methods of hand-weaving may be given, and the present staff is unable to cope with the work. One additional weaving teacher has been engaged, bringing the number of peripatetic instructors up to eight. It is proposed further to increase the staff when suitable men have been found, but considerable difficulty is being experienced in this direction.

Plans and estimates for a leather training school have been submitted to Government and it is hoped that these will be sanctioned before long. The Government of India have made a non-recurring grant of Rs. 50,000 and a recurring grant of Rs. 5,000 a year for this school.

Leather Expert.—The demonstrations given by the Leather Expert in improved methods of flaying and curing are, apparently, greatly

appreciated by the local *chamars.* A ready sale has been found for an improved flaying knife introduced by the Department. This knife is of Sheffield make, but arrangements are being made for future supplies of Indian manufacture.

Electricity.—' Non-co-operation ' has unfortunately interfered with certain schemes for the introduction of electric light and power in some of the smaller towns. The installation at Khandwa should be working before the close of the year and that at Jubbulpore early in 1922. Much useful information has been collected by the Electrical Engineer in his census of power prepared in connection with the Hydro-Electric Survey.

Scholarships.—Proposals have been submitted to Government for the creation of four post-graduate scholarships in applied chemistry.

Price index.—Arrangements are being made to collect the information required in connection with a price index for industrial workers, and this will necessitate the careful investigation of family budgets.

Welfare of factory workers.—The approaching visit of the factory humidification expert is awaited with interest. His investigations will, it is considered, be of considerable importance to the welfare of the workers in our cotton mills. At the request of the proprietors, a co-operative credit society is being organized amongst the people employed in the Empress Mills, Nagpur. The co-operative societies in the Gun Carriage Factory, Jubbulpore, continue to work well. Problems connected with the health and welfare of factory workers are engaging attention.

The Advisory Board of Industries is being enlarged and its functions will be widened.

H. R. CROSTHWAITE.

Director of Industries

Madras

Board of Industries.—Meetings of the Board of Industries were held in May and June. The following questions, amongst others, were included in the agenda of the meetings and considered by the Board:

(1) Proposals for the establishment of a demonstration textile factory at Madras.

(2) The re-organization of the sugarcane crushing station at Pallapaliyam and the future conduct of the experiments.

Alizarine dye.—In view of the fact that regular consignments of alizarine dyes are now being received from the British Alizarine Company and that supplies of this class of dye are now plentiful, Government have abolished the system of control under which Messrs. Best & Co. and their agents were restricted to selling the dye to persons included in the list drawn up of *bonâ fide* dyers. The removal of control became urgently necessary to enable the agents of the British Alizarine Company to sell the dye to all and sundry and to get as much British dye into the Indian market as possible before the competition of German dyes became serious.

Exhibitions.—The Department participated in an Agricultural and Industrial Exhibition held at Tirupur, and exhibited a range of soaps manufactured at the Kerala Soap Institute, Calicut, and inks manufactured at the Industrial Laboratory, Coonoor. The Kerala Soap Institute and the Industrial Laboratory were awarded silver medals for their exhibits.

Arrangements are being made for a comprehensive exhibit, representative of the various activities of the Department, to be sent to the industrial exhibition which will be held at Bezwada during the *Kistna Pushkaram* festival in August next, at which from four to five hundred thousand people from all parts of the Presidency are expected to be present. It is hoped that, as a result of this exhibition, the services offered by the Department will become more widely known in the Northern Circars.

Coir industry.—The question of the development of the coir industry in the deltas of the Godavari, Kistna and Cauvery Rivers and the Uddanam tract in Ganjam, where there are large areas under cocoanut, has been under consideration for some time past, and the investigation so far carried out indicates that it is mainly a question of devising and introducing suitable methods for the retting and extraction of the fibre. As regards retting, the question is what methods, if any, natural or mechanical, can be substituted for the special conditions which have favoured the development of the coir industry in Malabar and Travancore with their extensive system of brackish back-waters.

Publications.—The Oil Chemist and Superintendent, Kerala Soap Institute, has written a bulletin on the cold process of soap manufacture, which it is proposed to publish in the form of a departmental bulletin with a view to its distribution to small soap manufacturers and others.

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The Weaving Expert and the Leather Expert are contributing to the Madras Year Book articles on hand-loom weaving and the tanning industry of the Presidency, respectively.

Electric power scheme.—In connection with a proposal to establish an electric generating station at Salem with a view to supply electric power to the various factories already established or under contemplation, the Public Works Department have, at the instance of the Director of Industries, carried out a reconnaissance of the Shevaroy hills for possible hydro-electric schemes. The preliminary investigation that has been carried out indicates that the Vaniar River is the most promising source of electrical energy. The cost of developing this particular scheme is estimated, approximately, at Rs. 18 lakhs and the power available for sale annually at three million units.

Scholarships at the Indian Institute of Science, Bangalore.—In 1919 certain scholarships were granted by the Madras Government to be held at the Indian Institute of Science, Bangalore. The object of the institution of these scholarships was the provision of adequate facilities for the technical training of well-educated young men of the Presidency for employment in chemical industries. In view of the prospective industrial development of the Presidency and the probable demand for industrial chemists, the Madras Government have now placed this system of awarding scholarships on a permanent basis and have raised the maximum number of scholarships tenable at a time at the Institute from 10 to 18, subject to the provision of the necessary funds.

Works schools.—With the assistance of Government, Messrs. P. Orr & Sons, scientific instrument makers, established last year the Orr Works School with a view to provide for the education of the young boys employed in their works. The practical classes are taught by the European Works Manager and the literary classes by a trained Indian teacher. The Government supported the school as an experiment to the extent of half the cost, and the development of the school has been carefully watched by the Department, as it is considered that a properly arranged apprenticeship in a commercial workshop, supplemented by class instruction, will go far to turn out capable artisans of the type required all over the Presidency.

The Madras Engineering Works have now arranged to establish a school on somewhat similar lines for the benefit of the young workmen employed in their foundry and workshops.

A large firm of printers in Madras have also applied for the assistance of Government in instituting works classes for the benefit of the boys employed in their press. The latter proposal is under consideration.

Miscellaneous.—The question of starting a factory for, or arranging for instruction in a number of industrial schools in, the manufacture of brushes from palmyra fibre is under consideration. The Trichinopoly and Malabar District Boards have offered to provide funds for the purpose of preliminary experiments.

The question of the manufacture and canning of sterilized milk has been under examination, but the investigation that has been carried out clearly indicates that the establishment of any such industry in India under the existing conditions of milk supply has little prospect of success.

C. W. E. Cotton,
Director of Industries

Punjab

Artcraft Depôt, Lahore.—The Artcraft Depôt is the outcome of the Sales Gallery first started in connection with the Central Museum, Lahore. The object of this Depôt is to encourage inter-provincial trade in India. It is the headquarters from which are distributed the art products of the province to buyers in India and to the British Industries Fair in London. At this fair in London last year Rs. 22,000 worth of business was done at the Province's first venture, all of which will go into the pockets of Punjáb workers and traders who have shown themselves capable of appreciating the value of export trade. There is every chance of a very large increase in this trade in the future. In order to further this progress, the Mayo School of Arts is now preparing and distributing to art-workers new designs in wood-work, lacquer-work, and silver-work. The object of these new designs is to produce works of Indian traditional patterns and decoration suitable to objects of utility, for which there is much demand amongst traders catering for the Christmas markets in Europe. This, it is believed, is the first attempt that has been made in a systematic way to improve the trade and artistic value of the Punjab artcraft works. There are innumerable objects of art made here which require expert advice and design to bring them into line with the ever

changing requirements of western markets. Those workers who can most readily adapt their craft to new requirements will reap the advantage. The Controller of the Depôt will be glad to receive enquiries and to assist workers with advice and designs applicable to their special craft.

The work of preparing an illustrated catalogue of the art products of the Punjab exhibited in the Museum is now in hand. This catalogue will add very greatly to the trade prospects of the Depôt, as its circulation to firms and traders in India will be the quickest and most effective form of advertisement. For the British Industries Fair next year a selection of the best of the exhibits will be made and sent with an artistically illustrated catalogue. These export catalogues will be distributed freely amongst buyers in London, Paris, etc., and will add very materially to the possibilities of doing an increased export trade.

Lala Ram Chand's show room.—A philanthropic citizen of Amritsar recently left a building at the disposal of the Amritsar Municipality for use as an industrial show room and school. The Amritsar Municipality transferred the building to the Department of Industries. The Central Weaving Institute has recently been moved to this building. It is intended, later, to open in the building a sales gallery and show room to contain articles manufactured in the Province.

Electricity.—A meeting was held at Simla at which recommendations were made to Government with the object of standardizing the nature of electric supply in the Province, at which it was resolved that alternating current should be encouraged as far as possible in preference to direct current. Certain standards, pressures and frequencies were recommended for universal adoption.

New factories.—Two new two-ton ice factories have been established recently at Lahore and one at Lyallpur.

Two more steam roller flour mills have also been established at Multan and Sargodha.

Substitution for coal.—The Assistant Director of Industries (Mechanical) has been collecting certain information regarding the utilization of vegetable waste as a substitute for coal, but no definite action has been decided upon. Meanwhile, this question is also being studied by the Forest Utilization Officer, Punjab, in so far as forest waste is concerned.

Mineral concessions.—Mining operations are steadily developing in the province. During the last quarter the Punjab Government has sanctioned one prospecting license for coal in the Jhelum district over an area of 5 acres, three prospecting licenses for oil over areas totalling, approximately, 56 square miles in the Gujrat and Attock districts, and one general prospecting license for coal, sulphur, etc. over an area of 564 acres in the Jhelum district. The Attock Oil Company have been making great headway, and it is understood that they will have a refinery in working order early next year. They have recently been granted a mining lease for oil over an area of about two square miles in the Attock district.

Saw mill apprentices.—Arrangements have been made with Messrs. Spedding & Co., for the training of apprentices in their saw mills at Jhelum. The course of training will ordinarily be extended over a period of two years. Each apprentice will receive a stipend of Rs. 14 per mensem for the first year and Rs. 20 for the second year. Arrangements for the accommodation of all students in one place will also be made. Ten apprentices will be engaged from the 1st October 1921.

Industrial survey.—Industrial Surveyors have completed their enquiries in connection with vegetable oils and the information collected is being collated in office.

Enquiries regarding raw materials, wool, and chemicals are now being undertaken by Industrial Surveyors.

E. A. Scott,
Director of Industries

United Provinces

Arts and Crafts.—Mr. Heard has returned from England where he had gone to participate in the British Industries Fair on behalf of this Government. The Arts and Crafts Emporium attached to the School of Arts and Crafts has developed apace. A note has been prepared on its activities and the improvement it has brought about in the design and technique of the artcrafts of this country.

Board of Industries.—There have been two important meetings of the Board of Industries, one on the 25th April in Cawnpore and the other on the 22nd June at Naini Tal. The two sections of the Board were amalgamated by His Excellency the Governor

acting on the advice of his Ministers. The non-official members were appointed for a period of two years. The Board can appoint sub-committees for specific purposes and include in them outsiders who are specialists in the particular subjects. The present Board consists of 17 members, the Director of Agriculture, the Registrar of Co-operative Societies, the Conservator of Forests, the Director of Public Instruction, the Chief Engineer, Irrigation Branch, representing the Hydro-Electric Survey, the Principal of the Technological Institute, one representative of each of the three important railways to be appointed by the Agent, three persons elected by the non-official members of the Legislative Council, two members elected by each of the two Chambers of Commerce and three nominees of Government, with the Director of Industries as President, and the Deputy Director of Industries as Secretary without a vote. The Board is thus constituted of representatives of development departments, captains of industry and men of affairs.

The business transacted by the reconstituted Board was as follows :—

(1) The pay of the clerical staff was assimilated in different technical and industrial schools.

(2) Provision was made for a provident fund of the State Railway type for the teachers and clerical staff of the different Government schools.

(3) Comprehensive proposals for the increase of the pay and improvement of the prospects of instructors in technical schools.

A clear distinction was drawn between stipends to be given to students attending the technical and industrial schools to serve as subsistence allowances and scholarships which are awarded on the result of examinations. Liberal leaving scholarships were provided to enable students to set up in business after they leave the school, and artizans' wages were pitched at a sufficiently high level to induce them to leave their work and come to school to improve their technique. The total amount paid in stipends at present stands, approximately, at Rs. 85,000.

A loan of Rs. 12,000 was recommended for the manufacture of lithographic ink.

A grant of Rs. 1,000 was made to an ex-student of the Benares Weaving Institute for improving his automatic machinery for weaving gold and silver *gota*.

The Director's suggestion for the appointment of a press-tool maker was approved.

A recommendation was made to Government for the purpose of subsidizing an oil factory for training oil apprentices of the Technological Institute and for working at its own cost a demonstration factory containing various types of oil pressing machinery.

The second meeting of the Board of Industries will be memorable in the history of the Department, in that His Excellency the Governor was present at its sitting to deliver a message to the members. His Excellency's speech has been fully reported in the press. The Board transacted its ordinary business after the withdrawal of His Excellency the Governor. The Hon'ble the Minister for Industries attended the deliberations of the Board throughout.

The business transacted consisted in approving a scheme for the training of foreman tanners in the Government Harness and Saddlery Factory, increasing a grant-in-aid to the Commercial Department attached to St. John's College, Agra, and the C. M. S. Industrial School, Sikandra, District Agra.

The question of the factory staff had already been decided at the January meeting of the Board. In addition to the staff proposed then, the Board agreed to have four factory inspectors, two graduates of a technical school and two drawn from the medical profession, one of the latter being a woman. The Board did not think that the time was ripe for providing a special health service. On the question of the employment of women before and after childbirth, the Board were of opinion that there would be insuperable difficulties in the path of legislation and decided that, if any maternity scheme were to be initiated, it should be purely voluntary. They considered that Government should help any such scheme.

Technical Education.—The committee appointed to consider the various methods of training electrical and mechanical engineers and foremen has submitted its report on the subject of the training of engineers. It has been suggested that only students who have studied up to Intermediate Science should be taken, that they

should be put through a course of two years' practical training in an engineering workshop, receiving concurrent theoretical education for 8 to 10 hours a week. They should then go through a practical course of training lasting over two years, and then, in their fifth year, specialize in one particular department of engineering. For the foreman type two systems have been recommended. In one the candidates will be apprenticed for 5 years in an engineering workshop and will receive concurrent theoretical training: in the second the students will undergo 3 years' training in a technical school, both in the class room and the workshop, and will then be apprenticed for 2 years in some engineering works. Government have not yet passed orders on the scheme.

Coal supply.—Coal shortage and restricted bookings on railways have cast a gloom over the industrial outlook. Glass factories have suffered considerably. They require the best coal and that coal is not available in the Jharia coal-field, supplies from which are earmarked for loco. and utility departments.

Joint Stock Companies.—Capital is shy, and though the latest report on Joint Stock Companies shows the registration of 54 companies, compared with 29 in the preceding year, the peak was reached some time in the middle of last year. Twenty two of these companies were miscellaneous trading and manufacturing companies and three were banking companies, started in the exclusively agricultural part of the province, *viz.*, Oudh. The total number of companies is now 232 with a subscribed capital of 255 millions and a paid up capital of 30 millions. It is a pity that there is this great divergence between authorized and paid up capital.

Foreign scholarships.—The foreign scholarship committee held its sittings for three continuous days and has recommended for the acceptance of Government a comprehensive scheme of foreign scholarships, the aggregate cost coming to something like £18,000 a year.

Labour situation.—Most of the strikes had ended by the end of the first quarter and there has been a considerable lull in the labour market. The last strike to end was the Oudh and Rohilkhand Railway strike. The management has accepted the intermediation of the Rev. Mr. Andrews. A railwaymen's union will be formed and recognized, and the representation that their pay should be assimilated to the pay given on the North-Western Rail-

way, but based on the relative cost of living in the two provinces, has been accepted.

Mr. Milner-White, I.C.S., who was deputed to Bombay to watch the organization of the Bombay Labour Department by Mr. McLeod, has been attached temporarily to the Department of Industries to arrange for the collection of family budgets and statistics of production.

V. N. MEHTA,
Director of Industries

MISCELLANEOUS NOTES

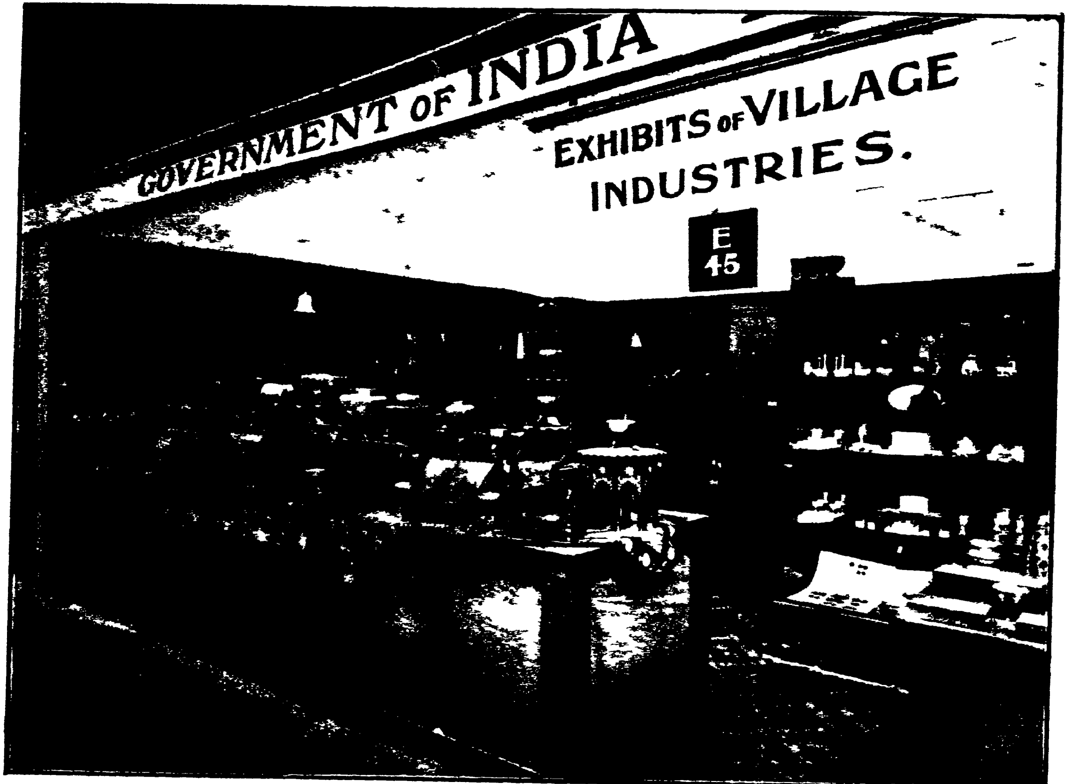
The British Industries Fair 1921

As in previous years, the British Industries Fair was held in three parts, in London for glass, pottery and other art products, in Glasgow for textiles and in Birmingham for hardware. The Fair opened at the White City in London on the 21st February 1921 and continued there until the 5th March. The Indian provinces participating were the United Provinces, the Punjab and Assam.

The arrangements for the Fair in London were under the direct management of the Department of Overseas Trade, while the exhibitions at Glasgow and Birmingham were promoted mainly by the local chambers of commerce. The exhibits from the United Provinces were placed in the charge of Mr. N. Heard, Principal of the School of Arts and Crafts, Lucknow, and the Punjab exhibits were similarly placed in the charge of Mr. H. L. Heath, Principal of the Mayo School of Art, Lahore. To these officers were also entrusted the arrangements for the sale of articles from the stalls and for booking orders from customers and the general supervision of the exhibitions. The preliminary work of engaging the necessary floor space, receiving the articles despatched from India and maintaining accounts for the whole of the Indian exhibition was undertaken by the Indian Trade Commissioner.

The reports received on the Fair have been distinctly favourable. The articles shown were good, and were, in the main, more generally suited for export and for sale in the United Kingdom than was the case with those exhibited in the previous year. In particular, the distinctive character of the stall in London reflected great credit on the participating Provinces and on the officers reresponsible for the selection of the exhibits, the greater measure of success attained this year being due to a large extent to the fact that the exhibitors concentrated on goods designed to serve useful purposes, a comparatively small proportion of the articles shown being of the 'curio' type. In his review on the results

BRITISH INDUSTRIES FAIR 1921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of the Punjab exhibits Mr. Heath places the articles shown in the following order of importance:

Inlaid tables, trays, cake-stands, etc.,
Lacquer work,
Painted brass work,
Multan pottery,
Perfumery,
Multan enamel work, and
Ivory.

The exhibition, generally, made an excellent impression on buyers, and many suggestions were received for improving designs and adapting ornamental articles to useful purposes. Particular interest was shown in the ivory exhibits by Her Majesty the Queen Empress who purchased four ivory boxes. In the cases of both the Punjab and the United Provinces considerable difficulty was experienced with pottery, which suffered from the journey to London owing to its fragile nature, and the general opinion was that it would not be advisable to continue to send articles of this nature to the Fair.

In estimating the financial results of the Exhibition it has to be borne in mind that the time at which it was held was characterized by severe depression in trade, whereas at the time of the 1920 Fair trade was booming and purchasers plentiful. Further, in 1920 the exchange value of the rupee was standing in the neighbourhood of two shillings, while at the time of the 1921 Exhibition it stood at 1*s*. 4*d*. A comparison of the results of last year's and this year's Exhibitions shows, therefore, a very much greater advance than is indicated by the figures in sterling of sales effected and orders booked. The quantity of business done at the last Fair actually amounted to between three and four times that transacted at the Fair of 1920. The general results of the Fair in figures are as follows:—

——	Cash sales	Value of orders
	£	£
United Provinces	614	1,940
Punjab	518	998
Assam	14	...
TOTAL	1,146	2,938
Total business transacted	...	4,084

Notwithstanding the adverse conditions, business was brisk where-ever goods of good quality were offered for sale, and the progress made should encourage a continuance of effort. Valuable pioneer work has been done and a considerable amount of experience collected which will be of use to Indian arts and crafts manufacture as a whole.

The report of the Committee appointed by the Board of Trade to consider the future policy in regard to British Industries Fairs has been received. The main recommendations of the Committee are as follows:

(1) That the Glasgow Fair should not be continued as part of the British Industries Fair.

(2) That the Birmingham Fair should be continued unless and until it ceases to receive sufficient support to justify its being considered as a national fair.

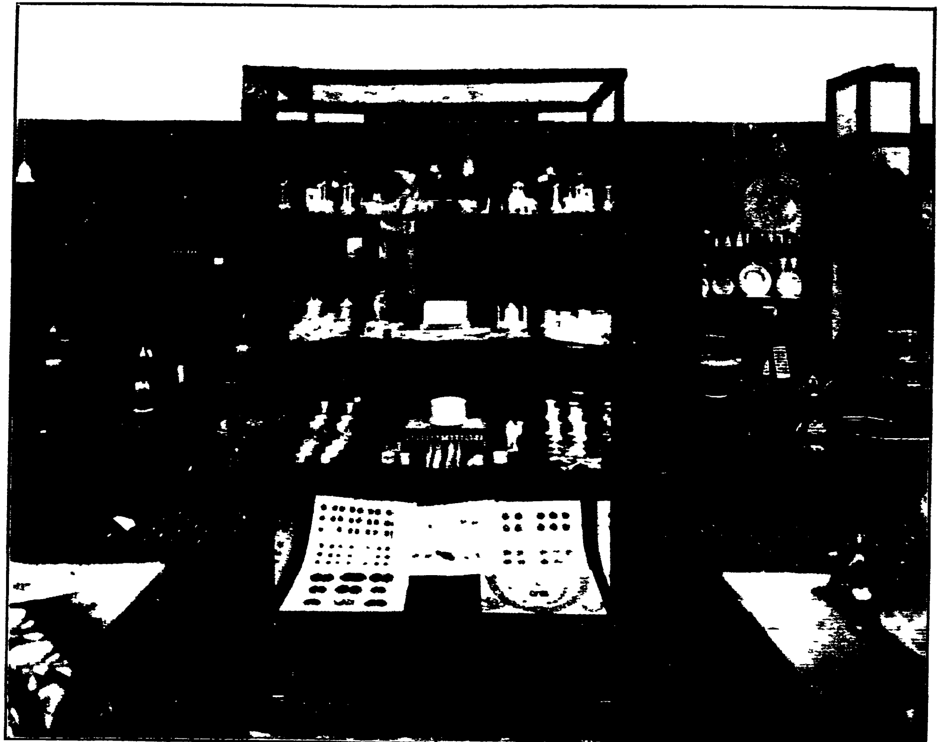
(3) That no new fairs should be opened in provincial centres.

(4) That the Fair should be open to all branches of British industries desiring to participate, the question of the allocation of trades as between the different centres being left to the discretion of the Department of Overseas Trade to determine in consultation with the respective Fair Committees.

(5) That the Fair should continue in the main to be restricted, as hitherto, to *bonâ fide* manufacturers and to wholesale firms taking the whole output of a factory or holding the sole selling rights of patented or proprietory articles manufactured in the British Empire. This principle may be relaxed in the case of textiles, and possibly in the case of other groups of products, if special conditions exist in regard to trade in them, but exhibits coming under such categories should be shown, if possible, in separate buildings.

In conclusion, the Committee draw attention to the need for systematic propaganda in connection with the British Industries Fairs.

While dealing with the subject of the exhibition of Indian products in England it may be mentioned that a proposal has been received by the Government of India from the High Commissioner that arrangements should be made for maintaining a standing ex-



BRITISH INDUSTRIES FAIR, 1921

hibition of Indian natural products and arts and crafts at his house in London. The scheme provides for the utilization of certain rooms as a public reading room, a reference library and an enquiry bureau for the use of Indians and others interested in India. It is further proposed to take the opportunity so offered to demonstrate the possibilities of Indian products for high class joinery and decorative work by panelling and furnishing certain rooms with Indian timber and by carrying out a scheme of mural decorations in others by means of Indian printed textiles in panels; at the same time maintaining the rooms themselves as permanent show rooms for exhibits from any province desiring to participate. The object of these show rooms should, it is proposed, be, not merely to arouse an interest in Indian arts and craftsmanship, but directly to further the sale of these products. The High Commissioner's proposal has been placed before the local Governments.

Hand-loom weaving

At the first Conference of the Directors of Industries, held in Simla in April 1920, the question of establishing a central experimental workshop for hand-loom weaving was discussed, and the conclusion was reached that it would be better to expand an existing weaving school rather than start an entirely new institution. It was finally decided that the weaving school at Benares would be the best place in which to develop. At the second Conference, held at Cawnpore in November 1920, the question was again brought forward, and the officiating Director of Industries in the United Provinces explained that he had prepared a scheme but that no final decision had been arrived at by his Government. The very great importance of the hand-loom weaving industry in India renders it desirable that an all-India weaving institute of the type under contemplation should only be established after careful consideration by the available experts in the country of the programme of work to be undertaken and the methods to be employed in carrying it through. The present position seems to be not altogether satisfactory, as the proposals have been made without consulting the various hand-loom weaving experts available in the different provinces of India.

A good deal of work has been done during the last twenty years and the status of the indigenous weaver has been greatly improved,

Not a little work has also been done to improve the technique and methods of the weavers of high-class goods; but comparatively little is known about such work, and, if care is not taken, it is likely that a valuable lot of experience which is still available will be lost. It seems desirable to have a conference of the weaving experts and of those officers who, in the past, have been actively associated with experimental work in hand-loom weaving. Mention might be made of the valuable work done at Salem, Serampore, Barabanki, Ahmednagar, Bangalore and Ludhiana. In no one of these weaving institutes has more than a beginning been made with the various problems which arise directly we try to rejuvenate what is, perhaps, the oldest industry in the world. It would be well to get all this information together so as to lose nothing of value of what has been done in the past in our future investigations.

With this object in view, the writer recently asked Mr. K. Sanjiva Rao, the weaving assistant in charge of the Bangalore Weaving Shed, to prepare a concise account of the work of which he has been in charge for the last eight years and of the results which had so far been obtained. The note submitted by Mr. Sanjiva Rao is somewhat lengthy and is of a highly technical character, which renders it, probably, of little interest, except to experts like himself and those officers of the Industrial Departments who have taken a practical interest in the matter of improving the lot of the hand-loom weaver.

The writer does not, therefore, propose to describe at any length the various machines which have been evolved in Bangalore. Most of them are of a simple character, some of them are very ingenious, and those that have survived the trials in the factory are unquestionably improvements upon anything that the hand-loom weaver at present possesses. A good many innovations have been introduced into the hand-loom, but they are chiefly adaptations to Indian conditions of inventions made in Europe during the period of the prolonged struggle between the hand-loom and the power-loom. The work of the greatest value and of the most originality has probably been done in connection with the preparatory processes. These are many, and, as now performed by the weavers, some of them are exceedingly tedious, and unless a great reduction in the amount of labour involved can be effected, there is little chance of introducing any very great advance in the hand-loom weaving industry. Much has been done to improve the methods of winding

bobbins and pirns, but the chief centre of experiment is round the warping and sizing mill. The results achieved so far are very promising, but they are far from complete and it is eminently desirable that efforts should be made to expedite progress.

For what they are worth the following ideas are submitted regarding the goal at which we should aim. We do not want to turn the hand-loom weaver into a machinist or make him a unit in a complex organization of the modern factory type. At the same time, it seems obvious that the present amorphous state of the community of hand-loom weavers must be provided with some kind of organic structure. To do his best the hand-loom weaver cannot work alone. There must be some sub-division of labour, both as regards processes of manufacture and the arrangements for marketing the products. The weaving co-operative society would offer an ideal solution if there were any one available with the necessary experience to lay down the lines upon which work should proceed. Elsewhere, and as an alternative, the writer has advocated the training of master weavers who would control small hand-loom weaving factories. Some of these have been started and have been moderately successful, but, generally speaking, it may be said that they can only flourish if the master weavers are altogether exceptional men, and, when they have discovered this, they not infrequently take to more lucrative pursuits.

Not one of the least important of the many problems which this all-India weaving institute will have to tackle is the application of electric power to reduce labour in the mechanical processes. It should be possible to produce a loom which will, in all essentials, be a hand-loom but in which the weaver should be saved the trouble of throwing the shuttle. A mechanically driven hand-loom may sound something like an Irish bull; but there is no reason why there should not be an intermediate stage between the hand-loom and the power-loom. It would certainly be a slow-running machine and many of its mechanisms will be comparatively light, but others, dealing with throwing the shuttle and beating up the cloth, would depend upon massiveness rather than velocity of motion. In Bangalore experiments in this direction have already been started and the results are promising, but it is by no means certain that they can be generally introduced.

A. Chatterton

A list of useful publications dealing with technical and industrial education.

1. *Coyajee, J. C.* (*Secretary, Provincial Advisory Committee for Indian Students, Calcutta*).—Admission to American Universities and Colleges, 1920. (Published at the Bengal Secretariat Book Depôt, Writers' Buildings, Calcutta.)

2. *Bureau of Education, India.*—Pamphlet No. 6 on Indian State Scholarships, 1919. (Published by the Superintendent, Government Printing, India, Calcutta.)

3. *Sorabji, R. K.*—Pamphlet No. 7 of the Bureau of Education, India, on Facilities for Indian Students in America and Japan, 1920. (Published by the Superintendent, Government Printing, India, Calcutta.)

4. *National Indian Association, London.*—Handbook of Information for Indian Students relating to University and Professional Studies, etc., in the United Kingdom, 1920. (Issued by the Committee of the National Indian Association in conjunction with the Students' Department, India Office, and published by the National Indian Association, 21, Cromwell Road, London, S.W.)

5. *Capen, S. P.*—Opportunities for Foreign Students at Colleges and Universities in the United States, 1915. United States Bureau of Education No. 27 of 1915. (Published by the Superintendent of Documents, Government Printing Office, Washington, D.C.)

6. *Yearbook of the Universities of the Empire.*—Published annually for the Universities Bureau of the British Empire, London.

7. *Roman, F. W.*—The Industrial and Commercial Schools of the United States and Germany, 1915. (Published by G. P. Putnam's Sons, New York and London.)

8. *Board of Education, London.*—Regulations for Technical Schools, Schools of Art, and other forms of provision for further education in England and Wales. (Printed under the authority of His Majesty's Stationery Office by Eyre and Spottiswood, Ltd., East Harding Street, London, E.C.)

REVIEWS AND NOTICES

Determination of optimum temperature and state of sub-division for maximum extraction of tannin from goran bark. BY B. B. DHAVALE AND S. R. DAS.

This forms the title of the second paper contributed to the Journal of the Society of Leather Trades Chemists, Leeds, from the laboratory of the Calcutta Research Tannery. The importance of the paper lies in the fact that this is the first chemical investigation of an Indian tanning material from an infinite variety in which the Indian forests abound. It promises to be the first of a series to follow.

The material under investigation is *goran* bark (*ceriops roxburghiana*) and the chief points investigated by Messrs. Dhavale and Das are the optimum conditions of its extraction for direct use in tanning, or for the manufacture of extract. The researches of Procter and Parker have shown that every tan-stuff has an optimum temperature at which it yields its maximum amount of tannin. It is also generally recognized that the finer the sub-division of the material, the greater the amount of tannin it yields at a particular temperature. But the maximum fineness for practical purposes is limited by the fact that a very finely powdered mass gets clogged in the extraction vats and thus prevents free percolation of the extracting material through it. Similarly, as in the case of temperature, therefore, there seems to be an optimum sub-division for the extraction of each tanning material. In the present investigation the authors have studied these optimum conditions for the extraction of *goran* bark.

Goran belongs to the botanical order *rhizophoraceæ* and forms a part of the mangrove forests of the Sunderbans (Bengal). A good deal of trade in *goran* logs is done in Calcutta. The logs are used for house-posts and firewood, while the stripped bark is used mostly as a tan and sometimes also as a dye. The average tannin content of the bark is about 32 per cent.

The samples of the bark used in the investigations were collected from the Sunderbans by Mr. Dhavale, as the material obtainable in

the local market was found to be inferior. Preliminary investigations were conducted roughly by the lead acetate method, while the final results were arrived at by the official method of tannin analysis. The authors have come to the following conclusions, which, it is hoped, will prove to be of great value both to practical tanners and to extract manufacturers.

(1) The optimum temperature for the extraction of *goran* bark (*ceriops roxburghiana*) varies with the sub-division of the particles under extraction. The finer the size of the particles, the lower is the optimum temperature.

(2) The 4 mesh and 10 mesh sub-divisions have a common optimum temperature at 55° to 60°C.; the 20 mesh size has 50° to 55°C. as its optimum temperature, while that for the 60 mesh size is 45° to 50°C.

(3) The quantity as well as the quality of tannin extracted at the respective temperature ranges vary from one sub-division to the other. At its optimum temperature the 4 mesh sub-division yields 25·39 per cent., the 10 mesh 28·49 per cent., the 20 mesh 25·95 per cent., and the 60 mesh 34·79 per cent. of tannin.

(4) Although the 60 mesh sub-division yields the greatest quantity and best quality of tannin at the lowest temperature, it cannot be recommended as a suitable size for extraction as it would cause trouble by clogging during operation.

(5) Out of the remaining three sub-divisions, the 10 mesh sub-division allows the highest amount of tannin to be extracted consistently with a high ratio of tans to non-tans, and seems, therefore, to be the best suited for extract manufacturers.

The Health of the Industrial Worker. BY EDGAR COLLIS, B.CH., M.A., M.D., M.R.C.P., M.R.C.S. AND MAJOR GREENWOOD, M.R.C.P., M.R.C.S. (LONDON : J. AND A. CHURCHILL, 7, GREAT MARLBOROUGH STREET, 1921, 30s.)

The publication of this book signifies a distinct advance in the science of management. The authors assume a desire on the part of the employer to provide healthy working conditions for his employees and then proceed to describe how such conditions can be secured.

Dr. Collis has been one of His Majesty's Medical Inspectors of Factories and also Director of Welfare and Health in the Ministry

of Munitions. He has thus been in close touch with the problems dealt with and has himself helped considerably to raise the standard of requirements in factories in Great Britain. Dr. Greenwood, besides being an eminent statistician, was at the head of the Medical Research Branch in the Ministry of Munitions.

The book is divided into four parts: the first gives an interesting historical account of the growth of industrial legislation in England. The proper methods of handling data collected from factories are then explained. The science of industrial hygiene, of which this book is an exposition, is dependent on the collection and tabulation and analysis of such data. Factory managers can therefore render invaluable assistance by arranging to keep records in such a way as to render this possible. A recent publication of the Industrial Fatigue Research Board* contains a standard system of records which may be of use in this respect.

The second part of the book embodies the results of many recent researches on such subjects as industrial fatigue, the effect of industry on tuberculosis and cancer, the causation and prevention of accidents. The problems connected with the employment of women in industry are also dealt with, and it is interesting to note that one of the general conclusions of the authors is that the lives of women should be fully occupied, for both economic and physiological reasons.

In the next issue of this Journal we hope to deal at some length with the subject of industrial fatigue with special reference to India. Its importance as a predisposing cause of infection is emphasized by the authors, who maintain that the general effect of factory employment, where conditions are not hygienic, is to lower the resisting power of the workers.

In Part III of the work the authors indicate the means to be adopted to prevent the worker from suffering because of his employment. The foremost consideration in this connection is the kind and quantity of food. A study of enquiries made in the book under review clearly suggests that the efficiency of the Indian workman might be considerably increased if the subject could be studied here also, and if the labourer's family in this country could be induced to make the necessary alterations in their diet and

* *A statistical study of labour turnover in munition and other factories*, No. 13. Price 3s.

domestic economy. The use of alcoholic beverages by industrial workers is treated in a dispassionate manner. The subject of ventilation is also fully discussed, and practical suggestions given as to the best method of securing that employees do not suffer on account of having to work in ill-ventilated factories.

Certain general subjects, such as industrial wastage, medical supervision, etc., are dealt with in the later chapters of the book. Space will not permit us to do more than to refer to them. They will, however, well repay study. At the end of each chapter there is a complete bibliography which should be very useful to those who wish to go more fully into any of the subjects that fall within the purview of this comprehensive work.

G. M. B.

The Economics of Welfare. BY A. C. PIGOU. 976 PAGES (MACMILLAN. 36*s.* NET).

This volume reproduces in a revised and amplified form much of Professor Pigou's previous work, especially his *Wealth and Welfare*, published in 1912, and his *Principles and Methods of Industrial Peace*, which is now out of print. He has also incorporated in his book a number of articles and discussions published in various reviews during the last few years. The result is one of the largest books on economics ever written, and the average reader would have much preferred it had Professor Pigou revised and republished his earlier works, to which he might have added a new volume incorporating some of his new material.

The book is devoted to a study of the national dividend and its relation to economic welfare. Accepting generally Professor Marshall's view of the dividend, Professor Pigou proceeds to demonstrate that economic welfare is dependent on (1) the average volume, (2) the distribution, and (3) the variability of the national dividend. Proceeding to correlate the national dividend to actual welfare, he argues (1) that the larger the average volume of the national dividend is, (2) that the larger the average of the national dividend that accrues to the poor is, and (3) that the less variable the annual volume of the national dividend and the annual share of the dividend that accrues to the poor are, the more advanced is the economic welfare of a community likely to be. From these fundamental propositions he proceeds to study the chief influences

which affect the average volume of the dividend. In his analysis of the distribution of productive resources among different uses and different occupations Professor Pigou has ample scope for his well known analytical methods. This part of the book is one of the most closely argued (and most difficult to read) in the whole literature of political economy. In this part he covers much ground, including a most valuable discussion on State regulation of prices and supplies, and on monopoly. His chapters on State intervention in industry and its various bearings are perhaps the most valuable of the whole book.

From this discussion he passes on to analyse the relation of the national dividend to labour. In this section he gives a descriptive as well as an analytical account of the principles and methods of industrial peace, the hours of labour, the methods of industrial remuneration, unemployment, methods of engaging labour, distribution of labour, State intervention to raise wages, the minimum wage and the fair wage.

From his discussion on labour he proceeds to give an account of the relation of the national dividend to Government finance. This part of his work is practically a textbook in itself on the principles of public finance. In Part 5 he deals with the distribution of the national dividend. The main part of this discussion is devoted to the question whether, and in what circumstances, it is possible for the absolute share of dividend accruing to the poor to be increased by a cause which at the same time diminishes the volume of the dividend as a whole. Finally, in Part 6, he discusses the variability of the national dividend. Three mathematical appendices are added to his volume. It is impossible here to give in any detail even the contents of this huge volume, not to speak of the arguments or the conclusions. Apart from his many intricate arguments, Professor Pigou has a considerable amount to say on questions of practical politics, but, owing to its forbidding aspect, it is doubtful whether the value of the book will be properly appreciated by either economists or the public.

Annual Report of the Patent Office for the year 1920. (PUBLISHED IN THE GAZETTE OF INDIA, PART II, DATED THE 4TH JUNE 1921.)

The Report shows that the business of the Patent Office has increased to a large extent compared with the last year, part of

the increase being due to the renewed activities of former enemy subjects. Altogether 1,337 applications for patents and 880 applications to register designs were made in 1920, as compared with 1,039 and 884, respectively, in 1919. The Report gives details regarding the number of patents and exclusive privileges in force on the 31st December 1920, the number of applications for the extension of the patent terms dealt with during the year, the number of lapsed patents restored and the legislation undertaken in connection with patents. Tables are attached to the Report showing the places at which copies of the Patent Office Journal and specifications of inventions can be seen by the public free of charge and the number of inventions and designs applications made and the fees received since the year 1890.

Report of the Boiler Laws Committee. 173 PAGES. (CALCUTTA: SUPERINTENDENT GOVERNMENT PRINTING, INDIA, RS. 2 ANNAS 4.)

Owing to the fact that every province has hitherto been responsible for framing its own law and rules for the management and inspection of steam boilers, considerable differences have arisen in the standards and practice in force in different provinces. It has been impossible for manufacturers to construct up to any definite standard for India as a whole, and, as was pointed out by the Industrial Commission, trouble is caused to persons who purchase boilers from other parts of India, as the pressure allowable under the rules in force in different provinces may differ to a marked extent. Theoretically it is desirable that there should be uniform standards of design and working for the whole of India. In practice two distinct systems have arisen in the management of boilers: in some parts of India the safety of the boiler is ensured by a system of inspection only, in other provinces local Governments further insist on the compulsory retention of a certificated person-in-charge of the boiler.

The Government of India wished to consider to what extent the existing differences could be assimilated by unification of the laws and regulations in force, and in November last appointed a Committee to deal with the question.

The Committee toured through all the major provinces of India and consulted manufacturers, users and importers of boilers, public bodies, local boiler inspection departments, local Governments and

Administrations and such expert witnesses as were available. They submitted their report to the Government of India on the 10th March 1921, and their proposals are now under consideration in consultation with local Governments.

The main proposals of the Committee are contained in a draft all-India Act, on the basis of which legislation may be undertaken, a draft set of regulations for the material, design, construction, registration and inspection of boilers to be made by the Government of India, and a model set of administrative rules for the guidance of local Governments. The Committee lay stress on the fact that uniformity of standard, and accordingly of maximum permissible working pressure, cannot be obtained and maintained unless inspection of boilers in all provinces is subject to the same Act and the same technical regulations. They accordingly propose that the Government of India alone should have power to frame and amend the Act and Regulations. They point out that, in these circumstances, manufacturers will be benefited by having a single standard as the basis of construction, while the importer and owner will know that any boiler constructed up to the standard can be used at the same maximum permissible working pressure in any part of India.

The Committee have arrived at the conclusion that the law compelling the person-in-charge of a boiler to possess a certificate should be abolished. They show that the system originated for the benefit of steam machinery generally 50 years ago, when knowledge of engineering in India was at a very low level, and that its origin was based on and due to a false analogy with the requirements of marine engines and boilers. They show that the present system of certificates is very defective, that it prohibits the semi-literate or illiterate mechanic, from which class an admirable type of boiler attendant is recruited in many parts of India, especially for the railways and Royal Indian Marine, from holding charge of any but the smallest type of boiler, that it affords no safeguard to large boilers, and that for the prevention of accidents, efficient inspection and care and observation on the part of the attendant are far more essential than theoretical training.

Apart from the omission of the provisions relating to certificated attendants, the draft Act prepared by the Committee contains few novel features. It aims at securing more efficient inspection and a more regular system, which will avoid delay and consequent

obstacles to industry. The Committee press for a considerable improvement in the status of Chief Inspectors, who will constitute the key-stone of the proposed system. The inspection staff should be a Government service under the administrative control of provincial Directors of Industries. A system of registration of boilers at the time of their first use in India is suggested to ensure that the boilers attain the required standard. It is proposed to exclude prime-movers entirely from the Act, but to include main steam pipes, defects in which are the most frequent cause of explosions.

The Committee have prepared regulations for the material, design and construction of boilers, based mainly on the Board of Trade's latest regulations for Marine boilers, published in 1920. These have been adapted for land boilers of all types, constructed in or outside of British India. These regulations are entirely technical, and the Committee suggest that, before they are brought into force, leading boiler manufacturers in the United Kingdom should be consulted through the Board of Trade. The remaining regulations control the registration and inspection of boilers and steam pipes; it is pointed out that, if a uniform standard is to be maintained, it is essential that the system of inspection should be uniform over the whole of India. The proposed system aims at increased efficiency, but does not result in the placing of any additional burdens on the boiler owner.

The actual details of administering the Act and Regulations will, of course, continue to rest with local Governments, and the labour of the Committee has accordingly been confined to the framing of Model Rules which may serve as a guide to local Governments in carrying out the intention of the proposed Act.

F. D. A.

PUBLICATIONS OF THE GEOLOGICAL SURVEY OF INDIA

Records, Geological Survey of India, Vol. LI, part 4, including the following papers:

(1) *Illustrated Comparative Diagnoses of Fossil Terebridæ from Burma* By E. VREDENBURG.—This paper is preliminary to a more exhaustive monograph on the Tertiary molluscan fauna of India, and deals exclusively with Tere-

bridæ regarded as previously undescribed. It is illustrated by a plate of 26 types.

(2) ***Indian Fossil Viviparæ.*** By N. ANNANDALE.—The author, who has made a special study of the Viviparidæ, contributes a sequel to a former paper on the fossil Viviparidæ of Upper Burma. Four species, ranging in age from late Cretaceous up to Quaternary, are described with the assistance of a plate of seven photographs.

(3) *On a new fossil Unionid from the Intertrappean Beds of Peninsular India.* By B. PRASHAD.—The interest of this communication lies in the fact that the specimen described constitutes the first fossil representative of the genus *Lamellidens* hitherto recorded. Its occurrence throws some light upon the question as to when the genus *Lamellidens* branched from the genus *Unio*. Thirteen small photographs illustrate the paper.

(4) *Uniondæ from the Miocene of Burma.* By E. VREDENBURG and B. PRASHAD.—The forms described were discovered at Chaunggyauk and Didokpin in the Irrawadian series and include the first fossil representatives of this Pelecypod family so far recorded from Burma. The two species described belong to different genera, and are illustrated by eleven photographs.

LIST OF PUBLICATIONS RECEIVED IN THE DEPARTMENT OF INDUSTRIES, GOVERNMENT OF INDIA

(FROM 1ST APRIL TO 30TH JUNE 1921)

I. Books

The Making of Leather. By H. R. Procter. 153 pages. (Cambridge University Press. 2*s.* 6*d.*)

Silica and the Silicates. By J. A. Audley. 374 pages. (London: Bailliere, Tindal and Cox. 16*s.*)

Modern American Tanning, Volume II. 570 pages. (Chicago: Jacobson Publishing Company. $5.)

Rules for Compositors and Readers at the Oxford University Press. By Horace Hart. (Oxford University Press. 1*s.* net.)

The Indian Year Book 1921. 882 pages. (Bombay: Bennett, Coleman and Co. Ltd. Rs. 7.)

A Monograph on Indian Railway Rates. By S. C. Ghose. 595 pages. (Calcutta: Superintendent, Government Printing, India. Rs. 3.)

Provincial Geographies of India.

(1) The Punjab, North-West Frontier Province and Kashmir. By Sir James Douie. 373 pages. (Cambridge: Cambridge University Press. Rs. 7.)

(2) Bengal, Bihar and Orissa and Sikkim. By L. S. S. O'Malley. 317 pages. (Cambridge University Press. Rs. 7.)

Printing for Business. By Joseph Thorp. 180 pages. (London: John Hogg. Rs. 7 as. 8.)

The Engineer's Year Book, 1921. 2,696 pages. (London: Crosby Lockwood and Son. £1 12*s.*)

Tanners' and Chemists' Handbook. Milwaukee. 363 pages. (Broadway: S. E. Tate Printing Company. £1 4*s.*)

The Determination of Hydrogen Ions. By Clark. 317 pages. (Baltimore: Williams and Wilkins Company. £1 14*s.*)

Stock Exchange Year Book, 1921. 2,728 pages. (London: Thomas Skinner and Company. £2 10s.).

Extra Pharmacopœia. 2 Vols. By Martindale and Westcott. 1,115 and 688 pages. (London: H. K. Lewis and Co., Ltd. 27s. and 17s. 6d. net.)

Industry and Finance. By Kirkaldy. 150 pages. (London: Sir Isaac Pitman and Sons., Ltd. 5s.)

Reconstructing India. By Sir M. Visveswaraya. 333 pages. (London: P. S. King and Sons Ltd. Rs. 7 as. 8.)

History of Socialism. 2 Vols. By M. Beer. 361 and 413 pages. (London: G. Bell and Sons Ltd. £1 7s. 6d.)

Industrial Training. By N. B. Dearle. 596 pages. (London: P. S. King and Sons Ltd. 10s. 6d.)

Wages and Capital. By Taussing. 329 pages. (New York: D. Appleton and Company. 12s. 6d.)

The British Trade Union Congress: History and Recollections. By W. J. Davis. 158 pages. (London: Co-operative Society. 1s. 8d.)

The Present Law of Trade Disputes and Trade Unions. By W. M. Geldart. 61 pages. Oxford University Press. 6d. net.)

Industrial Peace. By L. L. F. R. Price. 127 pages. (London: Macmillan and Company. 6s.)

Problems of Modern Industry. By Webb. 286 pages. (London: Longmans Green and Company. 7s. 6d.)

The Rowan Premium Bonus System of Payment by Results. By Sir W. Rowan Thomson. 99 pages. (Glasgow: Mc-Corquodale and Company. 10s.).

The Osborne Judgment and After. By W. M. Geldart. 46 pages. (London: Manchester Guardian Ltd. 3d.)

The Labour Movement. By L. T. Hobhouse. 159 pages. (London: T. Fisher Unwin. 1s. net.)

History of Labour Representation. By A. W. Humphrey. 196 pages. (London: Constable and Co., Ltd. 2s. 6d.)

An Introduction to the Study of Prices. By W. T. Layton. 194 pages. (London: Macmillan and Company. 7s. 6d.)

Piece-rate, Premium and Bonus. By J. E. Prosser. 122 pages. (Edinburgh: Neil and Co., Ltd. 6s.).

Labour Troubles and How to Prevent Them. By Herbert N. Casson. 207 pages. (London: The Efficiency Magazine 10s.)

Garton Memorandum on the Industrial Situation After the War. 175 pages. (London: Harrison and Sons. 2*s.* net.)

Efficiency Ideals. By Thiselton Mark. 127 pages. (London: T. Werner Laurie, Ltd. 2*s.* 6*d.*)

Profit Sharing Between Employer and Employee. By Gilman. 460 pages. (New York: Cambridge Riverside Press. 13*s.*)

Principles of Labour Legislation. By Commons and Andrews. 559 pages. (New York: Halper and Bros. 12*s.* 6*d.*)

Industrial Warfare: The Aims and Claims of Capital and Labour. By Charles Watney and James A. Little. 553 pages. (London: John Murray. 9*s.* 6*d.*)

London County Council. Trade and Technical Education of France and Germany. 47 pages. (London: P. S. King and Son. 1*s.*)

Labour in Madras. By B. P. Wadia. 240 pages. (Madras: S. Ganesh and Company. Rs. 2 as. 8.)

Library Classification and Cataloguing. By J. D. Brown. 261 pages. (London: Grafton and Company. Rs. 10.)

The Mining Manual and the Mining Year Book. 840 pages. (London: The Financial Times. £1 1*s.* 4*d.*)

Reports on the Progress of Applied Chemistry. Vol. V. 640 pages. (London: Society of Chemical Industry. 15*s.* 2*d.*)

II. Official Publications

(*a*) *H. M. Stationery Office, London*

The Assay of Coal for Carbonization Purposes.

Publications of the Imperial Mineral Resources Bureau: (1) Zinc, (2) Antimony, (3) Cobalt, (4) Aluminium and Bauxite.

Imperial Mineral Resources Bureau—Second Annual Report—Standard Time Rates of Wages and Hours of Labour in the United Kingdom.

Report on Conciliation and Arbitration (Conciliation Act, 1896, and Industrial Courts Act, 1919).

Statistics of Compensation and of Proceedings under the Workmen's Compensation Act, 1906, and the Employer's Liability Act, 1880, during the year 1919.

Report on Light Castings Under the Profiteering Acts, 1919 and 1920.

Report on the Top Making Trade Under the Profiteering Acts, 1919 and 1920.

Report on a Scheme for Maximum Retail Prices for Coal in London.

General Report on the Commercial, Industrial and Economic Situation in Denmark, Italy, Norway and Spain at the close of the year 1920.

Report on the Commercial Situation in Siam at the close of the year 1920.

Safeguards of Industries (Proposed Ways and Means Resolution).

Statistical Abstract for the United Kingdom from 1905 to 1919.

(*b*) *Government of India*

Proceedings of the Meeting of the Board of Agriculture held at Pusa on the 7th February 1921 and following days.

Memoirs of the Department of Agriculture in India (Chemical Series), Vol. V, No. 9, Vol. VI, No. 3, Vol. VII, No. 3 (Entomological Series).

Forest Bulletins (1920 and 1921).

No. 41 of 1920. Note on weights of seeds.

No. 97 of 1920. Note on Italian millet.

No. 98 of 1921. The course that surra runs in camels when naturally contracted and when artificially inoculated.

No. 99 of 1921. The course that camel surra runs in ponies, buffaloes and other animals.

No. 116. A survey of the Indian poppy-growing districts for morphine content of the opium produced.

Forest Records. Vol. VIII, Part 1. Report on Lac and Shellac.

Memoirs of the Geological Survey of India, Vol. XLIV, Part I.

Records of the Geological Survey of India, Vol. LI, Parts III and IV.

Note on Shellac manufacture in the United Provinces and Bihar.

Proportion of Fat in Casein (Bombay Industries Department Bulletin No. 4).

Note on Silk-worm Breeding in Burma. B. J. Clague.

Report on the Burma Soap-sand Industry.

Report on Cotton Growing, Ginning, Spinning and Weaving in Burma.

Report on Development of Industries in Burma.

Tanstuffs of the Sundarbans Forest Division. Pilgrim.

Progress Report of work done at the Calcutta Research Tannery, July to December, 1920.

Report of the Deck Passenger Committee.

Resolution on Immigration Labour in Assam, 1919-20.

Report on the Enquiry to Bring Technical Institutions into Closer Touch and More Practical Relations with the Employers of Labour in India.

(c) *League of Nations*

Rules of Procedure of the Assembly of the League of Nations.

Procès-verbal of the 9th and 10th Sessions of the Council of the League of Nations, held in Brussels and Paris, respectively.

Official Journal of the League of Nations. Resolutions passed by the Assembly at its first Session (Special Supplement).

League of Nations Council Documents. Russian Refugees.

(d) *International Labour Office*

Reports on the Control of Opium Traffic, the Traffic in Women and Children, and the Claims of India to be represented on the Governing body of the International Labour Office.

Regular Periodical Publications

1. International Labour Review.
2. Official Bulletin.
3. Daily Intelligence.

Irregular Periodical Publications

1. Studies and Reports—Series A to F, H and K.
2. Bibliographical Series.
3. Legislative Series.

(e) *Official Gazettes, Reviews, etc.*

Labour Gazette, London.
Labour Overseas, London.
Industrial Gazette, Queensland, Brisbane.
Statistical Bulletin, N. S. W., Sydney.
Labour Gazette, Canada, Ottawa.
Statistical Abstract, Perth, West Australia.
Abstract of Statistics, New Zealand, Wellington.
N. S. W. Industrial Gazette, Sydney.
Bulletin Du Ministère Du Travail.
Bulletin de La Société de Chimie Industrielle.
Labour Review, Washington.
International Labour Review, Geneva.
Postal Union Bulletin, Lucknow.

EXCHANGE LIST

THE FOLLOWING PERIODICALS ARE RECEIVED REGULARLY IN EXCHANGE FOR THE PUBLICATIONS OF THE DEPARTMENT OF INDUSTRIES, GOVERNMENT OF INDIA.

India

(1) *Indian Business*, Bombay.
(2) *East and West*, Simla.
(3) The *Hindustan Review*, Allahabad.
(4) The *Indian and Eastern Engineer*, Calcutta.
(5) *Industry*, Calcutta.
(6) The *Indian Review*, Madras.
(7) The *Indian Textile Journal*, Bombay.
(8) The *Journal of the Indian Economic Society*, Bombay.
(9) The *Modern Review*, Calcutta.
(10) The *Mysore Economic Journal*, Bangalore.
(11) The *Postal Union Bulletin*, Lucknow.
(12) The *Wealth of India*, Madras.

Abroad

(1) The *Asian Review*, Tokyo.
(2) *Bulletins of the Imperial Institute*, London.
(3) The *Canadian Export and Oversea Markets Review*, London.
(4) The *Chemical Age*, London.
(5) The *Chemical News and Journal of Physical Science*, London.
(6) *Chimie et Industrie*, Paris.
(7) *Cotton* (The Manchester Cotton Association Ltd.), Manchester.
(8) *Helvetica Chemica Acta*, Basel (Switzerland).
(9) The *Indian and Eastern Druggist*, South Croydon, London.
(10) The *Industrial League and Council Journal*, London.
(11) The *Journal of Industrial Welfare* (Industrial Welfare Society), Westminster, London.

(12) The *Journal of the American Chemical Society* (Ohio State University), Columbus, Ohio. U. S. A.
(13) The *Journal of the Franklin Institute,* Philadelphia. U. S. A.
(14) The *Labour Gazette* (Department of Labour, Canada), Ottawa.
(15) The *Leather World,* London.
(16) The *Labour Gazette* (Ministry of Labour), London.
(17) The *New South Wales Industrial Gazette* (Department of Labour Industry), Sydney, Australia.
(18) The *Perfumery and Essential Oil Record,* London.
(19) The *Philippine Journal of Science* (The Government of Philippine Islands, Department of the Interior Bureau of Science), Manila.
(20) The *Pharmaceutical Journal* (Pharmaceutical Society of Great Britain), London.
(21) The *Queensland Industrial Gazette* (Department of Labour), Brisbane, Australia.
(22) The *Shoe and Leather Record,* London.
(23) The *South African Journal of Industries* (Union of South Africa, Department of Mines and Industries), Pretoria.
(24) The *Monthly abstract of Statistics* (The Government of New Zealand), Wellington, New Zealand.
(25) The *Quarterly Statistical Bulletin* (The Government of New South Wales), Sydney, Australia.
(26) The *Quarterly Statistical Abstract* (Government of Australia), Perth, Australia.
(27) The *Textile Mercury,* Manchester.

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SUPERINTENDENT GOVERNMENT PRINTING, INDIA
8, HASTINGS STREET

ERRATUM

Page 337, Vol. I, Part 3—

In lines 2 and 3 of the last paragraph *for* '100 lb.' *read* '112 lb. (hundredweight).'

JOURNAL

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CHOTA NAGPUR AND ORISSA

BY

B. ABDY COLLINS, I.C.S.,

Director of Industries, Bihar and Orissa

The Province of Bihar and Orissa falls into two fairly well defined parts, Bihar, and Chota Nagpur and Orissa. The geographical division between the two does not quite follow the political boundary, since nearly the whole of the Santal Parganas and the extreme south of Shahabad, Gaya and Monghyr partake more of the nature of Chota Nagpur, but the contrast for all practical purposes is complete.

The contrast of Bihar

Bihar proper is a purely agricultural tract, which, except on the northern and southern borders, is an alluvial plain. Every available acre is cultivated by the teeming population and, save in Purnea and Champaran, there is little or no forest and hardly any pasture land. A fuller description of it may be attempted some day. For the present purpose, it is enough to say that such industries as it has or is likely to have must, as a general rule, be based on agricultural products or the needs of agriculture. The chief of these at present are sugar making, oil pressing, indigo manufacture, the production of saltpetre and sodium sulphate from the efflorescence of the soil and engineering works which supply material for these or for the railways. Others of importance that

may develop are tanning, jute and linen manufacture, rice hulling and the production of fertilizers, while the hand-loom industry has possibilities. In the south, where the plain touches the hills, we find a lime and cement industry in the course of development, mica and other minerals and, in the Santal Parganas, coal and china clay. There are signs of coal too on the Nepal border.

Chota Nagpur and Orissa have a very different future. Except for the narrow strip of alluvial country formed by the deltas of the Mahanadi, the Brahmani and the Subarnarekha, the whole area is an undulating laterite formation with pockets of rich soil and here and there salubrious plateaux and lofty hills. Of the total area of 69,468 square miles a large part is under forest, and the population averages only 210 to the square mile, and, if we except Orissa proper, where the density is 362, only 170.

Geography, population and means of transport

It consists of three main civil divisions, Chota Nagpur, Orissa and the Feudatory States. The bulk of the population, except in the delta, is aboriginal, without labour prejudices, and it might seem expressly planted there by Providence for the development of the mineral wealth of this tract. This area is bounded by Bihar on the north, by Madras and the sea on the south, by the Central Provinces on the west and again by the sea and Bengal on the east. A small portion of Bengal itself, the Asansol sub-division of the Burdwan district and a portion of Bankura, belong geographically to Chota Nagpur and the former is already one of the most important industrial centres dependent on it. The tract is served by three main lines of railway. The Bengal Nagpur main line to Madras passes across the head of the Orissa deltas, the other Bengal Nagpur main line to Bombay intersects it, while the grand chord of the East Indian Railway skirts it to the north. There is no north and south communication except the short line from Asansol to Sini on the main line to Nagpur; and the line from Adra to Khargpur through Bengal is the direct means of access to Orissa. Besides the main lines, there are a network of railways in the Jharia coal field, a narrow gauge line from Purulia on the Asansol-Sini chord to Lohardaga, branches from Son East Bank on the grand chord south to Daltonganj, the capital of Palamau district, from Jharsuguda on the Nagpur main line to Sambalpur and from

Tatanagar to the Gurumahisini mines, and the Mayurbhanj State Railway, a narrow gauge taking off from Rupsa on the east coast line. Except for the last two short lengths of line and the small portion of the Nagpur line which skirts the north, the huge area of the Feudatory States is as yet without railways. It has few roads, and its main rivers are only navigable for country boats for a portion of the year. Chota Nagpur is at present but little better served than the Feudatory States, except in the north-western and western corner. The Orissa coast tracts are traversed by the main line to Madras, which has but one branch to the coast, and that to Puri where no harbour exists. The harbours of False Point and Chandbali, such as they now are, are not connected with the hinterland by rail, nor can they accommodate ocean-going vessels of deep draft.

Natural resources

Coal

This undeveloped country contains nearly all the coal and most of the iron ore hitherto located in India, besides other minerals such as copper, chromite, mica, limestone, manganese, monazite, graphite, bauxite, china clay and fire clay. Its main importance lies in its coal and iron deposits and their juxtaposition. Of the coal fields now worked, those in Bihar and Orissa yield nearly 70 per cent. of the total output of India; while, if the Raniganj field is added, the production in the two provinces would amount to no less than 90 per cent. of the whole. The Jharia field alone produces over 50 per cent. of the coal raised in India, while the Bokharo mines, which are in process of opening up, will soon add largely to the total. In addition to the existing fields, quantities of first class coal have been located to the west. In the north and south Karanpura fields huge deposits of first class coal are available out-cropping to the surface in thick seams, one of which is said to be at least 100 feet wide. To the west, again, are the Aurangar and Hutar fields forming the end of a long chain towards the Daltonganj field on the west, though more coal again has been found outside the province. To the north of Dhanbad is the small Giridih field, at present being worked by the East Indian Railway and producing some 4 per cent. of the total output of India, while far to the south lie the Hinginrampur mines near Sambalpur and the newly proved

field at Talcher in the Feudatory State of that name to the north-west of Cuttack.

Iron ore

The important deposits of iron ore hitherto located in Chota Nagpur and Orissa are in the Kolhan sub-division of Singhbhum district and in the states of Mayurbhanj, Keonjhar and Bonai. The Tata Iron and Steel Co originally relied on the iron ores of Gurumahisini in north Mayurbhanj, but the neighbouring deposits of Badanpahar and Okampad are also being opened up. They are extremely rich, averaging over 60 per cent. of iron and in some cases as much as 67½ per cent.; but they are small in comparison with the vast deposits that have recently been located in the Kolhan and north Keonjhar. The north-western corner of these deposits had been worked for some years by the Bengal Iron Co., but the quality and extent of the ore to the south was unsuspected. Recent discoveries have shown vast deposits of hematite ores in quality equal to the Myurbhanj ores and in quantity only to be reckoned in thousands of millions of tons. The development of these ores and their linking up with the coal fields to the north, where coal suitable for blast furnace coke is available, is now in progress. Extensive limestone deposits, suitable for use as a flux in metallurgical operations, are found in Gangpur State to the west, close to the Bengal Nagpur Railway main line. Two of the most important are located near Panposh and Bisra.

The only firms at present producing pig iron are the Bengal Iron Co., whose head quarters are at Kulti just across the Barakar River which divides Bengal from Bihar and Orissa, and the Tata Iron and Steel Works at Jamshedpur in Singhbhum, a few miles north of Tatanagar station on the main Nagpur line. The latter alone produce steel.

Existing iron and steel works

The Bengal Iron Co.

The Bengal Iron Co., after a chequered career during which it twice attempted to manufacture steel, has now settled down to a solid prosperity based on the production of pig iron and castings made from it. There are now five furnaces, four always in blast, with a daily output of 450 tons of iron. "The iron foundries cover an area of approximately 120,000 square feet and include pipe foundries, sleeper foundries

and a foundry for special castings, this latter being especially equipped for heavy work. There is also a modern machine shop for machinery castings." During the five years 1916-20 the production of castings averaged 25,000 tons, but a new sleeper foundry which will be finished this year has a capacity of another 25,000 tons per annum. Coal supply is drawn from the Company's collieries at Ramnagar adjacent to the Iron Works, and at Jharia, while limestone flux is obtained principally from Sutna but also from deposits on the Bengal Nagpur Railway near Bisra. The site of the works was originally chosen on account of the proximity of both coal and ore deposits, but the local iron ore is no longer used and the blast furnaces depend on the ore obtained from the north-western corner of the Kolhan ore beds.

Tata Iron and Steel Works and its subsidiaries

The well known Tata Iron and Steel Works obtain their iron ore from Mayurbhanj, their limestone flux from Panposh and Rajgangpur and their coal from the Jharia and Raniganj coal fields. The plant at present consists of three blast furnaces, with a capacity of 900 tons of pig iron per diem and seven steel furnaces capable of producing approximately 17,500 tons of steel ingots a month. In the rolling mills, steel-rails, joists, angles, channels, tees, fish-plates, and rounds, squares, and flats of various sizes are produced. The average outturn of pig iron for the five years ending 1920 was 194,500 tons, of rolled steel products (including steel rails) 98,900 tons and of steel rails alone 48,500 tons. The exports from Jamshedpur by rail in the year 1919-20 were 50,000 tons of pig iron, 75,000 tons of steel rails and 60,000 tons of bars, girders, etc., valued in all at just under 5 crores of rupees. Further extensions are in course of erection. Two more blast furnaces capable of producing 1,000 tons of pig iron daily are nearly completion and a new *duplex* steel plant capable of producing 1,000 tons of ingots a day is also being erected. The erection of a plate mill has been completed, and as soon as this commences operation, steel plates, which have hitherto not been produced in India, will be available for the manufacture of railway wagons and the repair and building of ships. In addition, mills for the production of sheet bars, sheets, merchant bars, and a new rail and structural mill are in course of erection. To utilize the various materials produced by the company a number

of subsidiary companies which will undertake manufacture at Jamshedpur have been and are being formed. These include the Calcutta Monifieth Works, which are already producing machinery for the jute industry; Enamelled Ironware Ld., which will manufacture plates, cups and other utensils; the Tinplate Company of India, which will produce tin plates chiefly for use by the Burmah Oil Company and other oil companies in India; the Agricultural Implements Co., which will make ploughs, etc.; the Indian Steel Wire Products Ld.; the Enfield Cables Co. and the Hume Pipe and Construction Co. The most important of all the projects, the smelting of zinc and production of sulphuric acid in large quantities in conjunction with the Burma Corporation has, unfortunately, fallen through.

Besides the two existing iron and steel companies, three more large concerns and one smaller one are being planned. The Indian Iron and Steel Co. is erecting its works at Hirapur on the line joining Adra to Asansol just across the Bengal border. This company, which will at first produce only pig iron and castings, will draw its supplies of ore from Gua in the south-western corner of Singhbhum by means of the new Amda-Jamda extension, which leaves the main Nagpur line at Amda, passes through Chaibasa and, after approaching the southern border of the district, turns sharp to the west. Flux will be brought from Gangpur and coal supplies will be obtained locally. The output of the plant now under construction will be 600 tons of pig iron daily.

New iron and steel companies

The Eastern Iron Co. is to be established in close proximity to the Jharia coalfield. This company aims also, in the first instance, at producing only pig iron and will obtain supplies of ore, flux and coal from much the same localities as the Indian Iron and Steel Co. Another, more ambitious, enterprise is the United Steel Corporation of Asia which, it is understood, will be established at Manoharpur on the main Nagpur line near the western boundary of Singhbhum. This company will obtain its iron ore from the Kolhan and Keonjhar deposits and its coal from the new Karanpura coal field with which it will be joined by a new line passing directly north through Ranchi to the south Karanpura field. This company is understood to contemplate the production, not only of pig iron,

but of steel in its various forms, including steel plates. The Kirtyanand Iron and Steel Works near Sitarampur, also just across the Bengal border, is a small concern which will at present merely produce iron and steel castings from Indian and imported pig. It has already started operations.

Other metallurgical industries

Copper and other metals

The only other metallurgical industry which seems likely to succeed in this area at present is the production of refined copper. For many years the existence of a long narrow vein of copper running from north-west to south-east across the Dalbhum pargana of the Singhbhum district has been known. Early attempts to work the vein failed, chiefly on account of lack of railway communication. Soon after the building of the main Nagpur line, the old mines at Rakha just to the east of Jamshedpur were taken over by the Cape Copper Co. which, after many delays and difficulties caused chiefly by the great war, is at last producing refined copper of 99·5 purity and, given adequate supplies of fuel and flux, which owing to the wagon shortage' are not forthcoming, could turn out 2,000 tons per annum. Its actual outturn is nearer 1,200 tons—a convincing example of the great loss which India suffers from the restricted development of her railways. A second company, called the Cordoba Copper Co., is engaged in exploiting the same vein further to the west, but it will be some time before it is in a position to produce metallic copper.

No attempt is now being made to refine the chromite and manganese ores occurring in the district, although they are mined and exported or else used as refractory material. Ferro-manganese was made by the Bengal Iron Co. during the war at the special request of Government as an emergency measure, but it seems improbable that this industry will ever attain much prosperity owing to the high average content of phosphorus in Indian coal, which finds its way into the finished product.

Subsidiary industries

One important subsidiary to the metallurgical, as well as to many other modern industries, is the production of refractory materials, such as fire bricks, silica bricks, etc. The main sources of supply at present are in the north-east corner of this area where

the Kumardhubi Fire-clay and Silica Brick Co., the Reliance Fire Brick and Pottery Co. and the works of Messrs. Burn & Co. are situated. Without these materials for the lining of furnaces and retorts the metallurgical industry could not thrive in any country, and it is a matter for congratulation that it has been possible to produce continually improving refractories of all kinds in close proximity to the various iron and steel works.

Refractory materials

Another subsidiary industry is the production of coke in by-product ovens. A number of these ovens is now in existence at Jamshedpur and Giridih and in the Jharia coal field itself, while others are in course of erection. The total output of ammonium sulphate and tar during 1920 is reported to have been 3,720 and 8,880 tons, respectively. The former is used to some extent in the tea industry, but the bulk of it is exported to Java where it is bought by the very planters who export such large quantities of sugar to India. The tar finds a fairly ready market in India and is now being distilled in Calcutta by the Shalimar Tar Distillery for the production of benzol, etc.

By-product coking

Other industries

The other important existing industries of Chota Nagpur are the production of mica, the production of lac and its manufacture into shellac and the hand-weaving industry. A large factory for the manufacture of British Portland cement from the limestone of the south Shahabad plateau is also under construction at Jopla in the extreme north-west of the area. These are rather outside the scope of this article but need a few words of explanation.

India supplies over 70 per cent. of the world's mica, and more than three-fourths of her contribution is mined on the borders of Bihar and Chota Nagpur, the chief centre being Kodarma on the grand chord. . Mica was originally exported only in the form in which it was recovered from the mine after being roughly trimmed to shape by hand. Subsequently it was discovered that inferior mica could be split into very fine laminations and cemented together into a product named micanite, which could be used for much the same purposes as mica itself. Hitherto Indian mica has been sold either in block form or as 'splittings'. Recently Messrs. F. F. Chrestien & Co.

Mica

have started the manufacture of micanite at Domchanch and hope eventually to export the bulk of their splittings in this form.

Lac

Lac is almost an Indian monopoly, though it is produced in relatively small quantities in the west of China, Indo-China, Siam and the Straits Settlements. Here again the great bulk of the lac produced in India, that is, over 86 per cent., comes from Chota Nagpur and Orissa and its fringe areas, *i.e.*, the north-eastern portion of the Central Provinces, the western districts of Bengal and the southern portion of the Mirzapur district of the United Provinces. Formerly the principle centres for the manufacture of shellac, the form in which lac is usually exported. were Mirzapur and Calcutta, but the fortunes of Mirzapur are rapidly on the decline and the centre of the industry has now been shifted to Bihar and Orissa, where Balarampur and Jhalda in the Manbhum district, Pakaur in the Santal Parganas and Imamganj in the south of Gaya produce the largest quantities. The value of the industry to Bihar and Orissa may be gauged from the fact that the exports from India in 1920 are recorded at 8 crores of rupees, a large portion of which must have passed into the hands of the landholders, cultivators and labourers of Chota Nagpur and Orissa.

The hand-loom industry

The only other existing industry of importance is the hand-loom industry. In Chota Nagpur half the cloth consumed in the province is woven on the hand-loom and in Orissa the proportion is actually three-fourths. Between them the weavers of the whole area in 1919-20 produced about 50 million yards of cloth worth not less than 2½ crores of rupees. But this cloth is woven on the primitive pit loom, under every disadvantage, both in the purchase of raw material and in the sale of the finished article. With the introduction of the fly-shuttle loom and other improvements, which is proceeding apace, and the organization of co-operative stores, this industry should receive a great impulse in the near future.

Difficulties in the way of industries

This concludes the review of the chief existing industries of Chota Nagpur and Orissa. The most important are the production of coal and coke, the manufacture of iron and steel, the mining and preparation of mica, the production and manufacture of lac

and the weaving of cotton cloth. All of them seem to have a bright future, but they are not without their difficulties. Throughout its existence, the coal trade in India has suffered from severe handicaps, the chief of which have been the insufficiency and variableness of its labour supply and the lack of transportation facilities, generally known as the 'wagon shortage.' The labour problem at the coal fields is in some respects very similar to labour problems elsewhere in India, that is, there are few resident miners and the great majority migrate to their homes for the sowing and cutting of their crops. This difficulty might have been overcome to a great extent by the utilization of machinery, such as electric coal cutters, conveyors and mechanical loading, had not constant difficulties in getting the coal away from the collieries prevented the free investment of capital in labour-saving devices. This is no place in which to discuss the problems of the coal industry. It is sufficient to say that the three remedies for the present situation seem to be the improvement of the existing lines, the opening up of new coal fields, where fresh sources of labour can be tapped and the coal taken away direct to the west and north-west without passing through the congested area round Asansol, and the development of the use of electric power in the existing mines. Rolling stock must be bought *pari passu*, but at present there is as much as the rails can hold. All of these remedies mean money, and money not in lakhs but in crores, and even hundreds of crores. But until it can be found the country will continue to suffer from coal starvation. To talk of industrial development or Government aid to industries in such circumstances is mere self-deceipt. No further advance is possible until factories can depend on a regular supply of coal and the sooner the Indian publicist realizes this, the better. Hydro-electric power may, and indeed will, ease the situation in some parts of the country and oil fuel will do so in others, but India's main source of power for many years to come must be coal.

The problems of the coal trade

The metallurgical industry

The metallurgical industry has for some time past reaped a golden harvest, but with a rising exchange and the renewal of foreign imports its lean years are now to come, and it will feel them all the more because it is practically the only industry in India which gets no benefit from the present tariff. Iron, steel and machinery still pay a customs duty of only 2½ per cent. *ad valorem*,

while the rate on almost all other commodities is 11 per cent. This differential treatment is a relic of a time when no steel was made in India and it is probable that, if the iron and steel companies are to survive competition from abroad, the duty on steel, at least, will have to be raised to the general level. Now that one firm is producing steel in large quantities and others are contemplating its manufacture, there is no longer any ground for special treatment, at least for those materials such as structural steel and steel rails which are actually made in the country. When Japan pays its steel manufacturers bounties of 33 per cent. on production and Australia imposes duties of 20 to 40 shillings a ton on pig iron, India should surely allow her steel companies at least to enjoy the general tariff. But even this act of justice and policy will help the industry but little in itself. The market for steel, and especially for steel rails, is very restricted, Government itself being the principal buyer; and since Government can import its stores free of duty, it follows that it can purchase foreign rails landed in India more cheaply than any private person. Consequently Government is in a position to compel the Indian producer to quote lower rates than he can obtain in the Indian market. Rules known as the 'Stores Rules' have, however, been promulgated which distinctly affirm that articles of Indian manufacture, if satisfactory in point of quality, should be purchased for Government use in preference to foreign goods, provided their price does not compare unfavourably with the cost of importing the latter, *inclusive of customs duty* and other incidental charges. Now that the steel industry seems likely to fall on evil times, it is essential for it that these rules should be interpreted very strictly.

Railway development

Chota Nagpur

Apart from these difficulties, the iron and steel, like the coal, trade depends on the rapid opening up of the whole area by railways. The main object of this article is to explain what is already being done and being contemplated in this direction. Jamshedpur is now being joined to the coal fields by a double line, while a new line from Amda, the next station to the west of Sini, is being constructed to the iron deposits of the Kolhan. These two lines will feed four out of five of the big iron and steel works with iron ore, while the Sini-Adra section has also to supply the Tata Iron and Steel

Works with coal. Their importance cannot, therefore, be exaggerated, and it is a matter for congratulation that they are already in hand. Further extensions and improvements will soon be necessary. After these the most important projects are the new lines, which will open up the Karanpura coal fields and allow coal from there to be taken away direct to the west to Daltonganj and beyond, and to the south towards Manoharpur and Central India. The latter line will supply the steel works at Manoharpur with coal and coke for its furnaces. When the former is further carried through from Daltonganj to Katni, it will allow coal to be sent to Bombay by a shorter lead and without interfering with the supply of coal to the north-west. It will, further, provide a main line for the East Indian Railway passenger traffic of the same length as the Bengal Nagpur line and will open up the huge limestone deposits lying between Katni and Daltonganj. The opening of this line is, therefore, also of pressing importance. It has already been surveyed as far as Daltonganj and beyond, and it is to be hoped that nothing will prevent its early construction. It should certainly take precedence over the line through Ranchi to the south, although this, too, is urgently required. The building of these two lines will open up the heart of Chota Nagpur and will eventually, it is hoped, make direct communication possible between Ranchi and Patna. The development of these new coal deposits will not only bring prosperity to the aboriginal population of Hazaribagh and Palamau, but will certainly lead to the starting of fresh industries. Another projected line is the chord from Vishnupur to Howrah (both in Bengal) which will give the Bengal Nagpur Railway a direct route from the Jharia coal field to the docks. For the moment this can wait, until the coal traffic to Bombay and Karachi shows signs of reverting to the sea route, but as soon as this change takes place, the construction of this line will afford great relief to the cold weather congestion.

The development of Orissa and the Feudatory States is at present less well secured. It is known that the iron ore deposits of the Kolhan extend south into Keonjhar and Bonai and that other minerals are available, but no project has yet been advanced for the extension of the railway from Jamda to the south. It has recently been discovered, however, that below the worthless outcrops of coal in the Talcher state, there lie one or more seams of first class coal, of which 30 to 40 million tons have already been

Orissa : a port

proved. A short railway line required to join these deposits to the main line of Madras will be surveyed this cold weather, and, as soon as the mines are developed and this line built, it will be possible to supply southern India with coal more easily and cheaply than before. It is even possible that the coal, though not of a real coking grade, may be utilized for smelting iron and Messrs. Villiers, Ld., who are the chief concessionaires in the field, are making investigations to this end. Should this prove feasible, pig iron can be produced at Cuttack only 50 miles from the sea. In any case, the development of this coal field will be sure to lead to the starting of other new industries at Cuttack, which is admirably situated at the head of the Mahanadi delta in respect of railway communication, water supply, factory sites and cheap labour. Two fair-sized tanneries are already in existence, while a project for the establishment of a mill to make paper pulp from bamboos floated down the Mahanadi from Angul and the Feudatory States is already well advanced. As soon as coal is available near by, others are likely to follow. What is now required to bring prosperity to Orissa and the States is the development of a port on the coast. Preliminary inquiries seem to show that a port capable of accommodating the largest ocean-going vessels might be developed at small cost at False Point, about 50 miles due east of Cuttack. This project has yet to be examined by an expert harbour engineer, and, until his opinion has been expressed, it is somewhat unprofitable to build what may only be castles in the air. Should it be favourable, however, the cost of linking the harbour up with Cuttack will be very small, since no bridging will be required. The harbour can then be connected with Central India by extending the Talcher line to Sambalpur, and with the iron and steel and coal industries by joining the Amda-Jamda extension to the Madras main line north of the Baitarni river. The Talcher coal field would then be the best situated for the export and coastal trade of any in India and a great trade in pig iron, iron ore and other minerals would be developed. The new port, too, could be laid out so as to land quickly and efficiently the heavy plant and machinery required by the metallurgical industry, for which Calcutta is at present imperfectly equipped.

With a first class harbour and these two lines, the future of Orissa, now with her alternate visitations of flood and drought a constant source of anxiety to Government, would be secured. The

distance from Sini to Cuttack by the new route would be the same as that from Sini to Calcutta, while the 50 miles further to the sea would not handicap a port from which the largest vessels could get out to sea in an hour instead of having to traverse the difficult and lengthy passage of the Hooghly. False Point, which is opposite the best grounds located by the *Golden Crown*, would certainly also become the centre of a steam-trawling industry and supply Calcutta and the industrial areas with sea fish. Calcutta herself has nothing to fear from the development of such a port. The population of Orissa and the Feudatory States is only 9 millions, while in Bengal, Bihar and the United Provinces Calcutta has a population of 120 millions to serve. The needs of this vast collection of people, the coal, jute and tea industries and the export trade in oil seeds and other crops will always tax her resources to the utmost and she need not cast a jealous eye on her poor sister to the south. Equally so, the new port of Vizagapatam would be little affected by the rivalry of False Point. Vizagapatam is shown on the map as being joined by a direct line to Nagpur and Central India, besides possessing a prosperous and thickly inhabited area of its own. It will also tap the already known mineral deposits of Patna and Kalahandi States, the two southern-most of the Feudatory States of Orissa.

Calcutta and Vizagapatam

Openings for Biharis and Oriyas

Many of these plans for the prosperity of Orissa may be dreams, should the report on False Point prove unfavourable; but nothing but anarchy and civil disturbance can prevent the rapid development of Chota Nagpur and the Feudatory States into one of the chief, if not the chief, industrial centre of India, the rival of Birmingham, Chicago and the Rhine. It is for the people of the province to bestir themselves and see that all the profits do not go into the pockets of other races. Much of the capital invested in the coal fields and the iron and steel industry is Indian. The Tata Iron & Steel Co. is an Indian concern and one of the new undertakings is largely backed by Indian capital, but so far the inhabitants of the province have shown little enterprise, either as promoters and managers of industry or even as higher grade employés. The coal fields are the happy hunting ground of the Bengali, and the iron and steel works find most, if not all, their responsible staff out-

side the province. Yet the field is open to all who are willing to leave their homes, to take off their coats and learn. The best education is or will be available either at Government institutions like the projected School of Mines and Sibpur College, or on an aided basis in the Jamshedpur Institute or through the Evening Mining Classes at Jharia. It requires some courage to break through the prejudices of caste and to leave the easy path of the 'genteel' occupations. But the other races are doing it, and unless they are to become the drudges of India the Bihari and Oriya must follow their example.

B. ABDY COLLINS

THE ECONOMIC ASPECT OF THE BOYCOTT OF FOREIGN CLOTH

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By some it is believed that the universal boycott of foreign (which means mainly British) cloth and yarn in India will bring about the political salvation of the people. A very large proportion of the output of Lancashire mills, it is argued, is consumed in India, and in the present depressed condition of that industry the determination of people in this country not to buy, sell and consume foreign cloth is bound to make a deep impression on Lancashire, and, through it, on the British Parliament. Some of the assumptions underlying this argument require a careful examination. Will the boycott be general and long-lived enough to produce the desired impression on Lancashire and the Imperial Government? The agitation of Lancashire against the enhanced import duties on piece goods has, indeed, lent colour to the impression that a curtailment of demand from India means the ruin of the British industry and that a successful boycott must bring the Imperial Government to its knees and grant *swarajya* to India. There is no reason to believe, however, that Lancashire, which resists the exercise by the Indian Government of the fiscal powers conferred on it, is likely to place more trust in a completely autonomous India, such as the grant of full *swarajya* will mean. Lancashire will rather choose to suffer losses than strengthen protectionist India by bringing pressure to bear on the British Government to grant larger political and fiscal powers to the Indian people. A nation which incurred a debt of £8,000 million in the recent war can certainly bear a loss of £60 million a year for some years (assuming that the boycott is completely successful), and may find other markets for its piece goods. Some favour the boycott of British cloth because it was the import of that cloth into India which ruined the indigenous weaving industry. Assuming that the selfish fiscal policy of England was responsible

for the destruction of our old handicrafts, how can they be rehabilitated by the mere exclusion of foreign cloth from our markets? We can understand the desire to give preference to cloth manufactured in India over imported stuff and the desire to produce larger quantities in this country on the power-loom and the hand-loom. This *swadeshi* is commendable and must be enjoined on all as an article of the faith of patriotism.

It must, however, be a comparatively slow process. India must be made to produce a larger quantity of finer raw cotton, and her mills must manufacture this raw material into the kind of cloth that is at present imported. India's capacity to turn out middling and rough qualities of cloth must, likewise, be increased. These are objects worth the sacrifice of every one who wants to promote the economic development of the country at a more rapid pace. The problem cannot be solved, however, by being attacked only on the side of demand. Governments used to pass sumptuary laws in the past and prohibited the use of certain qualities and kinds of commodities. The English Government did this in the eighteenth century and penalized cloth manufactured on Indian hand-looms. The present boycott movement may be regarded as an attempt to put into operation an unofficial convention in the nature of a sumptuary law. One would favour the boycott movement if one could be convinced of its economic beneficence. Foreign cloth is characterized as worse than poison and people are forbidden to touch it, and this is offered as a justification of the 'burning' movement. The use of foreign cloth is also described as a sin, and thus an appeal is addressed to the minds of the pious and the superstitious. But even in the case of the opium habit you can not cut it down with one stroke. And to boycott foreign cloth, without providing a substitute therefor, is not an effective way in which to promote the material well-being of the masses. Granting that the characterization of the use of foreign cloth as a sin is only an emphatic way of preaching *swadeshi*, we fail to see how salvation can be achieved by what is bound to be a temporary and a partial boycott. If the movement is intended to rehabilitate the hand-weaving industry, within certain limits, it is undoubtedly beneficial and worthy of support. But to expect all classes and conditions of people to discard all other cloth in favour of *khadar* is to put an undue strain on human nature. In ancient Sanskrit literature there are descriptions of kings in whose realms there were no thieves, no prosecution and no

taxes. One who desires to establish that ideal and idyllic state of things certainly cannot begin by abolishing the police and destroying the doors of all houses! Labour, when it is unemployed or under-employed, can be and ought to be given work on the looms and the spinning wheel, and nothing will be better for the leaders of the *swadeshi* movement than to pay special attention to this aspect of the problem. The boycott and the *charkha* are not, however, cure-alls. It is harmful to divert labour engaged in mills and factories and transport it to hand-spinning and hand-weaving. In the long run it is uneconomic. The boycott movement is at the bottom a movement of a moral, intellectual and social revolution. It is an attack upon machinery and modern ways of living. There is much in western civilization which, indeed, requires purification, and oriental civilization is not entirely immune from evils. Greater men than the promoters of the present movement have tried to wean away people from materialism, and have succeeded only partially. India cannot shut herself away from modern industrialism altogether. Her leaders can only keep under control the evil tendencies of the impact of western materialism. Preserve whatever is good in your civilization; utilize it by a contact with the outside. But do not try to return to a past which is not practicable nor altogether desirable.

Leaving out of consideration the purely political, ethical and spiritual aspects of the question, we may observe that the use of *swadeshi* cloth (not *khadar* exclusively) may be preached even if it entails a sacrifice on the consumer, and it must be practised by every lover of his country. Every effort must be made to increase the output of the necessaries of life and varieties of cloth, and other articles which involve the expenditure of manual skill and the exercise of good taste and imagination in their manufacture. Autonomous workers and cottage industries must be encouraged and hand-loom weaving can be rehabilitated in specific conditions. But it is madness to drive the country back to *khadar* and nothing but *khadar* and the primitive social conditions it means. You cannot do without machinery and India cannot afford to be reduced to the position of a barbarous country. We may admire the social and economic ideals of a saint, but we cannot follow them to the letter. The condition of labour cannot be improved unless workmen have larger real wages, live in better houses, can read and write and consume better food and clothing. The boycott movement, as

it is conducted, is not calculated to produce these results and cannot, therefore, receive the support of reasonable people. A movement which cannot increase national wealth and only creates temporary excitement stands self-condemned on the economic side.

V. G. KALE

SMOKE PREVENTION AND FUEL ECONOMY

BY

J. ROBSON, A.M.I.Mech.E.,

Chief Inspector of Smoke Nuisance, Bengal

Endeavours to deal with smoke reduction in Calcutta were initiated under the Calcutta and Howrah Smoke Nuisances Act of 1863, which provided that furnaces should be constructed so as to consume or burn their own smoke, and that the owner must use the best practical means for preventing or counteracting the smoke. That Act, which was under the control of the Bengal Boiler Commission, not proving satisfactory was repealed in 1905. In that year the Bengal Smoke Nuisances Act of 1905, which is controlled by a special Smoke Commission, was promulgated.

The Smoke Act of 1905 and the rules framed under it provide a standard for comparing the densities of smoke, and also provide that smoke of certain densities, if emitted for a longer time than permitted, constitutes an offence. The Ringleman's smoke scales were taken as the means for identifying the smoke, and the denser grades, Nos. 6, 5 and 4, corresponding to dense black, black, and very dark grey smoke, were accepted as the grades to be controlled, and a method was provided for expressing all the smoke of these three grades in terms of scale 6, or dense black smoke.

In 1906, when operations under the present Act were started, some of the chimneys continuously emitted smoke of scale 6, others smoke of scale 5, and some were fairly good. But the average emission of all the chimneys for the three grades of controlled smoke, when reduced in the usual manner, was the equivalent of 13·1 minutes of scale 6 (dense black smoke) during each hour.

The Smoke Act of 1905 was an improvement on the Howrah Act of 1863, as it provided an instrument of greater precision in dealing with offenders. But it only authorized action after the smoke had been manufactured, and permitted the erection of badly designed and wasteful furnaces, from which it was impossible to get a reasonable outturn or to prevent the emission of smoke, and then punished the owners for making smoke. It missed the important

fact that smoke is, apart from causing damage to the community, an indication of inefficiency, a waste of fuel and a national loss, and that efficient smoke prevention should start at the furnace end of the installation and not at the chimney top.

However, the Smoke Department made the best of the circumstances in which it was placed, and endeavoured to reduce the smoke as rapidly and efficiently as possible. The success of its endeavours have been acknowledged in the United Kingdom. In 1914, in the House of Lords, in supporting a Smoke Abatement Bill to consolidate and improve smoke regulations for Great Britain and Ireland, it was stated that "The Bengal Commission had been so successful that in less than three years it had diminished the dense smoke from factory chimneys by over 80 per cent." A scheme, which is entirely voluntary, for the training and examination of firemen for certificates of competency was sanctioned by Government. The firemen are divided into two classes, the ordinary stoker, and the tindal, or leading stoker.

The qualifications for an ordinary stoker are:

(*a*) he has to pass a satisfactory *viva voce* examination before the Inspectors, regarding:

(1) the uses and working of steam boilers and their fittings;
(2) the management of the different types of furnaces;
(3) the use of the various stoking tools;
(4) the effect of opening and closing dampers;
(5) the effects of too great and too small an air supply;
(6) the description of the various arrangements of flues and chimneys;
(7) the classification of the various kinds of coal and coke used, and their distinctive peculiarities as to steam raising and general heating efficiency; and
(8) the prevention of smoke; and

(*b*) he has to prove by practical test to the satisfaction of the Inspectors his ability to stoke various types of furnaces, and to apply any other test to which he may be subjected.

The qualifications for a tindal stoker are:

(*a*) he has to pass an advanced *viva voce* examination before the Inspectors in the subjects specified for the examination of an ordinary stoker.

(*b*) he has to explain to the satisfaction of the Inspectors the working of steam-engines and boiler feed apparatus, and

(*c*) he has to show by practical test to the satisfaction of the Inspectors his ability to be in charge of a range of furnaces.

The trained firemen effected an improvement, but this did not go deep enough. It was necessary to control the construction and re-erection of furnaces, flues and chimneys, etc. Many investigations and tests regarding smoke prevention, coal consumption and draught were made with a view to arriving at the best proportion of flues and chimneys to suit the local conditions. Proposals were submitted to Government and the Act was amended so as to provide that no furnace, flue, or chimney should be constructed, altered or re-constructed unless in accordance with plans previously approved by the Smoke Department. The areas of the flues and chimney are based on the fire-grate area, and are as follows :

	per cent. of the total grate area
(1) Back end or down flue	45
(2) Bottom flue	40
(3) Side flues	33
(4) Delivery flue to main	33
(5) Main flue connected to a grate having an area of less than 150 square feet	30
(6) Main flue connected to a grate having an area of 150 square feet or more	25
(7) Chimney connected to a grate having an area of less than 150 square feet	25
(8) Chimney connected to a grate having an area of 150 square feet or more	20

In the case of stationary boilers of the marine, locomotive, vertical and other similar types, the flues and chimney must not be of less area than the corresponding smoke outlets of the smoke box or uptake forming an integral part of the structure.

This was the end of the construction of wasteful furnaces, and initiated types designed to suit local conditions, from which the desired outturn could be obtained with the minimum effort on the part of the firemen. In some of the back number installations it was more difficult for the fireman to burn 10 lb. of coal per square foot of fire grate than to get through double the quantity with the improved furnaces. Stokers' work is hot and exhausting, and, particularly in the tropics, improvement of their conditions is neces-

sary both on humanitarian and on economic grounds. The modern furnaces are a great improvement on the old. and, as the owners state, apart from there being less smoke, they either get an increased outturn from the factory or a saving of fuel, or both. The saving of fuel in particular cases has been as high as from 10 to 30 per cent

The use of oil fuel instead of coal on ocean-going steamers is comparatively new and has greatly extended. Many of the steamers visiting the port were fitted with arrangements for burning this fuel. Some of them deluged the town almost continuously with smoke and oily soot, causing much damage regarding which many complaints were received. Investigations of the conditions under which the furnaces were worked showed that educational measures were imperative, and as each steamer arrived it was dealt with and improved as was found necessary. When oil is burnt the fuel is first raised to a temperature depending on the class of oil, and is then delivered under suitable pressure through the burner to the furnace where it is atomized to the condition of a fine mist and meets the necessary air. Obviously the more efficiently these factors can be manipulated so as to attain the desired conditions, the more efficient will be the combination as regards both the prevention of smoke and fuel economy.

In some steamers, when using the auxiliary boiler under natural draught, it was not possible to manipulate the necessary factors so as to get efficient and smokeless combustion. The owners of a large steamship line were addressed with special reference to the defects and invited to co-operate with the Department. In their reply they expressed appreciation of the efforts to assist them, hoped for their continuation and agreed to effect the alterations as opportunity occurred. The same owners recently added four large, new oil-burning steamers to their Calcutta service, all of which have since been altered in accordance with the suggestions made to them. After the alterations, and when using the auxiliary boilers, combustion was greatly improved, and the air supply was so efficiently distributed that it could be regulated so as to give very little over the ideal requirements, without giving smoke or soot. There was also a saving of 20 per cent. in oil fuel.

The necessity for using waste products has been greatly accentuated by the high price of and the difficulty of obtaining coal. In the area controlled by the Act there are nearly 100 rice mills, in

which the husks from the raw paddy are looked upon as refuse and are used for filling up tanks, etc. The burning of raw husks in the furnaces presents no great difficulty, but the objection is that the furnace gases are heavily charged with light soot and ash, which are thrown broadcast on the surrounding locality. Some years ago, before the Commission was invested with powers to control the construction of furnaces, etc., and when action could not be taken under the Smoke Act, attempts were made to burn paddy husks. But the soot and ash caused so much damage that, on the complaint of the surrounding residents, the arrangement was closed down under a magisterial order.

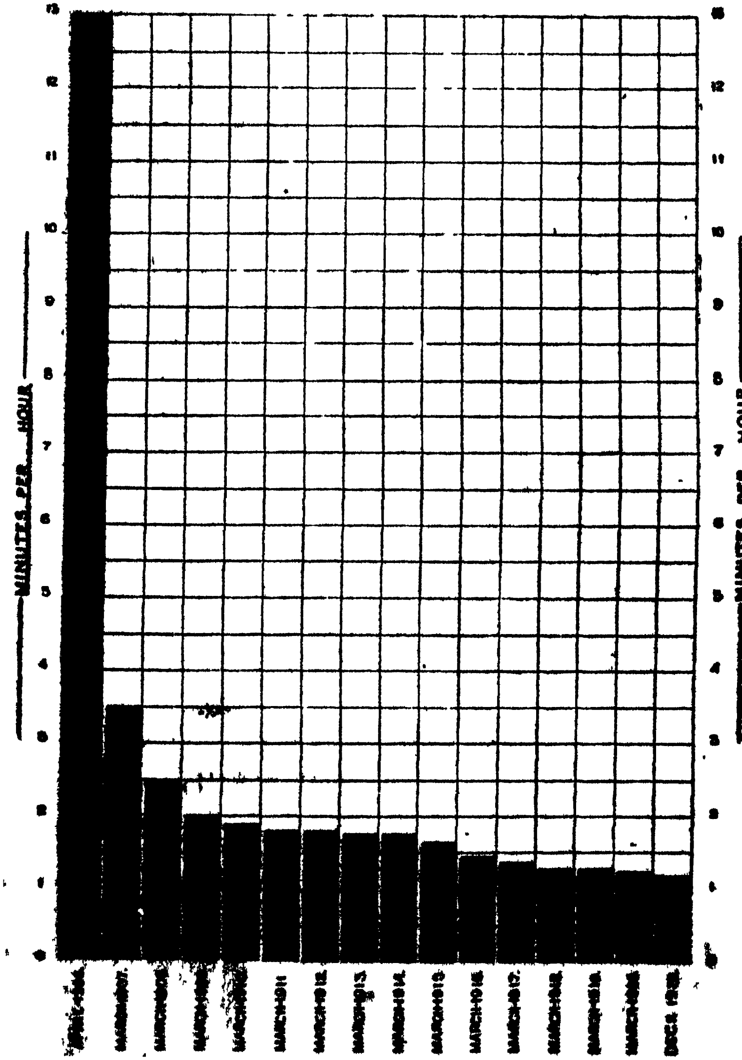
However, the present coal situation has recently caused some of the rice mills to burn paddy husks. An arrangement of flues, etc., designed to intercept the soot and ash is being considered. It is a difficult and an interesting problem, which, if successfully solved, will financially benefit the industry and, as it saves a considerable amount of coal daily, it will help to meet a very difficult situation.

Electric or gas installations are a permanent remedy for the smoke nuisance. A large number of motors are connected each year to the mains of the Calcutta Electric Supply Corporation, and the number is expected to be greater in future. Some of the smaller plants, for the same quantity of work, consume three to four times the quantity of fuel that is used in an up-to-date plant where the combustion and the heat losses are properly controlled. There are hundreds of such small plants in operation.

The application of gas to meet domestic requirements is also a large question, and obviously has a very important bearing on the general comfort and the public health of the community. The effects of domestic smoke in Calcutta are accentuated, in that the kitchen fireplaces, as a rule, have no chimneys and are adjacent to the residential quarters, into which they usually discharge the smoke and soot. Good progress is being made by the Oriental Gas Co. in fitting domestic cookers and also gas appliances for industrial furnaces, and it is expected that, when the advantages of these appliances are more widely known, their adoption will be accelerated.

Smoke prevention is an important measure in the interests of public health and property, but one which, to be successful, must not be repressive. It is necessary to secure the co-operation of the owners in the gradual installation of better furnaces and in the

DIAGRAM SHOWING THE AVERAGE EMISSION OF SMOKE OF SCALES 6, 5 & 4, EXPRESSED IN TERMS OF SCALE 6, FROM FACTORY CHIMNEYS WITHIN THE AREA TO WHICH THE PROVISIONS OF THE BENGAL SMOKE ACT APPLY.



scientific utilization of fuel which ensures to the highest degree smoke prevention, public protection and fuel economy. This has been the experience of all well controlled Smoke Ordinances, and Bengal is no exception.

It was hoped that gradually with the better furnaces, giving a greater outturn with less effort on the part of the firemen and also meeting the public health requirements of less smoke, attention and efforts would be directed towards reducing chimney losses, due to the quantity of air passing through the furnaces not being properly proportioned to the fuel consumed. Attention to these losses would, in many installations, effect a 20 to 30 per cent. reduction of fuel. This reduction of fuel is of great national, industrial and communal importance. It prolongs the life of the national resources that can never be replaced, lessens the demand on the public services concerned, and, as there is a reduction of gases discharged into the atmosphere, effects a corresponding improvement in public health and diminishes the damage to public property. However, it is satisfactory that matters are progressing in the desired direction. Some of the larger mills have fitted and are fitting recording and other instruments to measure and check the efficiency of the combustion of fuel in their installations, and, obviously, their extension is very desirable.

The following is an extract from the Pittsburgh Smoke Report of 1914—"A saving in laundry bills only of a little less than four cents per week per inhabitant equals more than $1,100,000 saved per year." Similarly, in Calcutta and the suburbs, with its one and a quarter million inhabitants, a very small sum per head gives a saving of many times the cost of the Smoke Department.

In 1906, when the Smoke Department commenced operations, the average emission of controlled smoke from each factory chimney was the equivalent of 13·1 minutes of dense black smoke during each hour. It has now been reduced to 1·22 minutes, or, in other words, 90 per cent. of the controlled smoke has been abolished. A diagram is appended illustrating the reduction.

J. ROBSON

TECHNICAL TRAINING

BY

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India undoubtedly possesses vast stores of natural wealth. A list of these would include timber, minerals, fibres, oilseeds, materials for making iron, steel, aluminium, pottery, leather, varnishes, chemicals, manures, paper, cement, glass, rubber and a host of other things. For power purposes there are coal, petroleum, fuel timber and water power. These natural resources are not of much value unless they are properly exploited. To do this India needs capitalists who are willing to invest their money, brains to direct industries, and a plentiful supply of skilled labour. There is capital in India, and men with brains can be had if the remuneration offered is sufficiently attractive, but there is no magic wand that can, with a touch, give knowledge and skill to ignorant and indifferent workmen. The word ignorant is here used not as meaning illiterate. A man can be literate and yet be ignorant and useless in a world that depends upon practical knowledge and manual dexterity for food, clothing and houses. Education is considered by some people to be a panacea for every drawback. While nobody desires to belittle the benefits of literacy, it is a fact that without being literate men can become very highly skilled and able craftsmen. The great industries of the West were built up long before compulsory education was introduced. In those days a very small percentage of the craftsmen who supplied the world with manufactured articles at cheap rates could read and write. Literacy confers advantages on any people, but what is wanted still more in Indian workmen is education in the principles underlying their craft, and manual dexterity which will enable them to produce much more with the same amount of physical effort.

A good workman is not necessarily a very strong man; he depends rather upon his brains and his skill. He eliminates unnecessary hand movements from his daily work. He measures correctly and cuts to the mark with precision, thus avoiding having to pare and true up, or, in other words, do the work over again. An Indian

oiner never attempts to save time and labour. When cutting tenons he always cuts them thicker and leaves the shoulders longer than they are marked. Then he has to pare and plane the tenon to the required thickness and chop with a chisel the extra material that he left on the shoulders. He does his work in this way because he is not skilful enough to cut with a saw exactly to the mark. His saws are never in such a state as to make it possible for anybody to cut true to the mark. Needless to say, this paring and chopping lengthens by several hundred per cent. the period in which the work can be done. Any man seen to be doing such a thing in England would be dismissed at once.

The way in which an Indian joiner sets about making drawers for a cabinet is almost painful to a man who has been trained in this work in the West. The Indian workman seems to do all the processes the wrong way about, or to use a colloquialism, upside down. If carried out in the right way, the making of a well fitting drawer is a simple matter. How often does one meet with a well-fitting and easy-running drawer in India of local manufacture ? To start with, the front of the drawer should be made to go into its opening, a close but not a tight fit. Subsequent operations should not interfere with this fit. The back of the drawer is similarly fitted, rather looser than the front. If when the drawer is finished, it remains the size of its back and front, it is bound to be a good-running and a well-fitting drawer. The sides are made to the length required and rather wider than the front and back. The extra width is planed flush with the front and the back after the drawer has been glued together. The dovetails on the sides are first cut. This allows of several pairs of sides being cut in one operation and explains partly why the Western joiner turns out so much more work than the Indian joiner. From the sides the dovetails on the back and front are marked with a dovetail saw. The depth of these dovetails is marked with a gauge which is set slightly less than the thickness of the sides. Therefore, when the drawer is glued together, the sides are slightly more than flush with the ends of the front and back. In planing the sides to clean them after the glueing process, this slight excess of thickness is planed flush with the ends of the front and the back. The whole drawer is then just as good a fit as the front and the back.

When every movement of the hands is directed by an intelligence that is bent upon saving time and physical energy, and when the right methods are known, more and better goods are produced.

More goods mean cheaper goods. Not until Indian workmen are instructed in labour-saving methods, will Indian products be able to compete in quality and price with foreign products.

Numerous instances can be given of the way in which time and energy are wasted by Indian workmen. The turner's primitive lathe is operated by a man who sits on the floor and pulls a strap which alternately winds and unwinds round the spindle. Instead of a continuous forward motion the spindle revolves forwards and backwards. During the backward revolution no work is done—therefore fifty per cent. of time is wasted; perhaps more than fifty per cent., because the tool cannot be applied on the forward stroke until the spindle has gained a certain momentum, and the tool has to be removed before the forward stroke is finished to allow the spindle to revolve to rewind the strap. This is the country lathe, inexpensive, but a waster of time and energy. On this are turned up the legs of chairs and tables, brass hollow-ware, metal and ivory ornaments. There are thousands, tens of thousands, of these lathes in this land, and each one wastes the time of one, and in most cases of two, men.

The potter's wheel is another waster of time. It is surprising that a man is content with a machine that is always coming to a standstill. It must be very annoying that the wheel slows up just when the vessel is being given the finishing touches. A good proportion of the potter's time is spent in giving momentum to the wheel, which could be done by a child turning a handle if another form of wheel were adopted. By this means the speed could be kept fairly fast and regular and there would be no slow running periods when the momentum is dying out. The result would be a bigger output.

The builder's labourer and the road-maker's labourer in this country seldom use a wheel barrow. The hereditary method of carrying a few pounds of earth or mortar or *gitti* on the head is preferred. In a wheel barrow a hundredweight of such material can be transported with no more physical effort. Why people prefer that their body should take the strain instead of putting the strain on a wheel is incomprehensible. The road sweeper prefers a short broom which strains his wrist and bends his back, to the leverage which a long handle affords and which will sweep a greater area in a given time.

The Indian tanner turns a good hide into bad leather which soaks up water like a sponge. In a country that abounds in a great variety of tanstuffs, he chooses those that only half tan his hides and neglects other valuable tanstuffs that would give his leather a body and render it more water-proof and more wear-resisting. He is unaware of the existence of many of these tanstuffs and he has little inclination for research and experiment. He is concerned in turning out what he calls leather, as quickly as possible, regardless of its wearing qualities.

Books bound in the country usually fall to pieces in the first rains. Plaster breaks away from projecting angles, almost with a touch ; and plaster ceilings, owing to the plasterer's lack of knowledge, will not stay up. Plaster ceilings have been condemned for this country because nobody knows how to put them up. Bazar-made cane or wicker chairs have a very short life ; their binding comes undone and insects work havoc. The cane worker never impregnates his materials to protect them from the ravages of insects. The *mochi* sews on the soles of boots with a stitch that gives way for an inch or two when it is severed at one point. The wax ends method which ties a knot at every stitch does not appeal to him as it takes longer and would rob him of the reputation he has earned for *kutcha* work. The painter's paint never seems to want to dry. The wheelwright, at least in the south of the Central Provinces, leaves a space of half an inch or more between his felloes for some reason, and by so doing robs his wheel of the strength it would have if the felloes butted together like the bricks of an arch. Stairs made in the country are narrow in the tread and high in the riser and are therefore dangerous to the users. The Indian plane will not smooth wood but tears up the grain ; the joiner has not yet learned to avoid this by using the back iron which is common to all English planes. The weld made by the *lohar* (blacksmith) is seldom an invisible one ; his scarves are usually too long and they fuse in the fire because he has not been taught to give them a coat of silica. The *lohar*'s idea of how an angle bracket for strengthening woodwork should be made is to bend the iron in a vice ; this renders the iron thinner and weaker where it ought to be thicker and stronger. This list could be lengthened almost indefinitely, but it is long enough to show that technical education is badly needed in this country and will have to be organized on a large scale if an improvement in local industries is to be brought about in a measurable time. Universal primary education

would not do much for the crafts of the country. Technical knowledge and manual dexterity are not acquired from books but rather by demonstration and example and much practice. Books do not play an important part until the apprentice or pupil reaches an advanced stage.

The Indian workman is quick to learn and under proper supervision is capable of good work. The railways of India can be pointed to in proof of this statement. Luxurious carriages are made, and they are made to stand tremendous wear and tear. This industry is a great training school for Indian artisans, and many thousands have received technical instruction from European foremen in railway workshops. But the percentage of the artisans of India who learn in railway and other workshops where Europeans are employed as foremen is very small. The vast majority of Indian artisans are likely to remain untaught unless some special agency is created. This agency is the trade school. Such schools should be started at every important centre, and they should be staffed with men who know the errors of Indian workmanship and who know what labour-saving methods should be taught. All boys of the artisan castes should be admitted, even though they may be totally illiterate The curriculum for such boys would be slightly different to the one for literate boys. For instance, though they could learn to make sketches, they could not learn geometry. There should be no upper age limit for such boys, but any youth or young man up to the age of twentyfive, who showed a desire to learn, should be admitted, even if only for a short course.

India must have these schools if her workers are to be trained to do more and better work. At first, and for many years, the teaching should be mainly practical, but more advanced subjects would be taught as the districts advance in which the schools are situated. These schools would always be needed. All the important towns in progressive countries have technical schools by means of which apprentices are able to increase their knowledge and thus improve their status.

The near future may see a great industrial development in this country. In the West, industry evolved gradually as new inventions and discoveries were made, but India has the whole of the invention of the West ready at her disposal and she can start at a point that has been reached after many years of patient research and after failures and loss. In other words, the path on which India may

travel has been made ready for her. Should this anticipated industrial development materialize, there will be a great demand for skilled labour. It would be wise, therefore, to start now to train this labour on a large scale.

E. E. A. COVE

THE MODERN PAPERMAKING INDUSTRY IN INDIA

BY

A. R. BARBOUR, O.B.E.

A motion was raised in debate on the Budget in the Imperial Assembly on the 15th March 1921 drawing attention to the need for economy in the use of paper supplies and suggesting that Government should buy their supplies as far as possible in India. It had the effect of eliciting from Government some interesting information as to the favourable results of their existing policy of buying Indian made paper, but the discussion disclosed that even in the best informed quarters there was a tendency to overlook or forget elementary facts relating to the paper industry and to its history in India. It may therefore not be out of place to endeavour to describe the situation of the industry and to touch upon some of the special features relating to its development.

The advent of the paper mill industry in India took place at a time when industrialists in Europe had just begun to appreciate the great change in the economic life of this country brought about by the introduction of railways. An enormous stimulus had been given to Indian trade of every description (export, import and internal). Encouragement had been afforded to an increasing degree of local specialization in the growth of particular crops and to the spread of demand for the products of modern industry throughout areas far distant from the ports. The great cotton mill industry which had made little or no progress when first established in Calcutta in 1820-1830 had been re-established in Bombay and there had commenced that transfer of jute spinning machinery from the banks of the Tay to those of the Hughli which was to prove the foundation of a great industry adding enormously to the wealth and prosperity not only of Calcutta itself but of the whole of India.

The principle which guided the early pioneers of the paper mill industry was essentially the same as that which led to the foundation of the cotton and jute industries, namely, the economic advantage, and indeed necessity, of providing manufacturing facilities at points

where a market existed and cheap raw material and labou were obtainable. By transferring manufacturing operations from Europe to India the cost of transporting raw material many thousands of miles could be saved, as also the expense of re-exporting the manufactured article. These benefits outweighed the disadvantage of detachment from the main indusrial organism. They 'u' y counterbalanced the inconvenience of isolation in a country where the evolution of the modern complex system of industry still lay in the future. The success of the cotton and jute mills proves the essential soundness of the elementary principles on which these undertakings were founded, but that success is nevertheless a limited one. Neither industry has attained in India the high standard of excellence obtained elsewhere in regard to qualities and nature of the articles produced. Their failure in this respect is due to the fact that India is still in the early stages of industrial development and is deficient in many things belonging to the more highly organized industrial communities. Until in India we have a cycle of industries mutually dependent upon and sustaining one another we can neither hope to reach the best standards of quality nor to produce on the most economical footing.

Few people realize "the complexity of the industrial machinery whereby alone commercial production is rendered possible to the mutual benefit alike of capitalist, workman and consumer" and in consequence fewer still realize the vast difference existing between industry as it is known in India and the system in Europe and American where there is "the most concentrated form of industrial specialization the world has ever seen." It is all the more necessary to dwell on this aspect since modern papermaking is not a mere series of mechanical operations such as constitute the functions of a jute or cotton mill. It requires a more highly specialized degree of technical science and its demands on scientific knowledge are of a much wider nature. This will be more readily understood if we say something of paper itself and the processes which go to its production.

Modern paper and papermaking processes

Unlike the ancient Egyptians and the Romans who built up sheets of 'paper' from fine layers of fibrous matter taken from the papyrus stem, the modern papermaker first reduces his fibrous matter to the condition of pulp and having separated, cleaned and bleached the fibres he throws them together by the aid of water

into a continuous sheet which is dried on the 'paper machine.' Thus perhaps the simplest and most complete definition of paper is that it is "an aqueous deposit of vegetable fibre." It is of interest to note here that the Chinese are credited with being the inventors of the system of making true paper by the preliminary reduction of the raw material to pulp. Their knowledge was carried to India by the Mahomedan invaders while it spread westward by Arab means and became known to Europe through the Moorish conquest of Spain and the Arab occupation of Sicily.

The modern processes of manufacture involve a good deal of chemical treatment. For the preparation of pure cellulose pulp the water solubles, starch, colouring matter and salts have to be removed, likewise fat and wax, pectose and lignin. The latter can only be removed by means of digestion with alkalis of acids. The chemicals used, the system of boiling, the temperature of digestion, the strength of the solutions, the duration of the cooking period and last but not least, the species of vegetable fibre used, are all determining factors in the nature and value of the ultimate product. In connection with these factors there are a great number of difficult and important problems. The pulp has to be produced in such a condition as to be readily bleachable at a low cost and to be of a nature which will lend itself to easy treatment in subsequent disintegration, dyeing, sizing and loading. In practical working the whole series of operations leading to the production of finished paper has to be very scientifically balanced and controlled.

It is unnecessary to enter into a detailed description of the processes already roughly indicated. They require in the first place abundant supplies of a number of different chemicals and natural products and if these are not available in close proximity to the paper mill the cost of paper production is seriously enhanced, especially if the distances over which they have to be transported are great, as in the case of mills situated in India. Again the machinery for the purposes of papermaking is of a highly specialized type and can only be obtained from centres where industry has reached a high degree of specialized activity. Accessories such as phosphor bronze machine wires, steel knives and bars, cotton and rubber rolls, cotton and woollen felts have but a short working life and have to be constantly replaced. These and the innumerable other special requirements of the paper trade have to be imported. All this means extra direct expense and involves as well the locking up of money not

only during the time articles are in transit to the paper mills but also in the provision of extra and most expensive stocks to provide against emergencies such as a strike or a breakdown in transport arrangements.

It will be clear then without further examination, that the case of the paper industry is somewhat more complicated than that of cotton or jute since its requirements are more extensive. The elementary principle of putting facilities for manufacture near the market, raw material and 'cheap' labour, is in these days overlaid by other considerations and in the present stage of development in this particular industry it may be more profitable to bring the raw material to a site in the vicinity of the centres of the chemical, engineering and weaving industries than to sacrifice all for the sake of economy in initial transport.

Introduction of the modern industry into India

When the paper industry was first introduced into India secondary considerations of the kind indicated required little attention owing to the fact that the raw material then in use was cotton rags. Cotton is the purest form of cellulose, requiring only a light treatment for the removal of the non-cellulose constituents of the plant and so long as cotton rags were available in sufficient quantity to meet the demand the question of the cheap supply of chemicals was perhaps of less importance than the need for a large supply of cotton rags and it was to tap India's resources of this waste material that the first paper mill on modern commercial and industrial lines was established in this country.

The earliest precursor of the modern mill in India was established by the missionaries at the Danish settlement of Tranquebar in 1716. Machinery for making paper in a continuous sheet had not then been invented, but in 1811, eight years after the first 'Fourdrinier' machine was built in England, the enterprising and famous missionary, Carey, set up a Donkin Fourdrinier machine at Serampore and this continued at work for many years in conjunction with the Missionary Press at the same place. These early missionary enterprises served their purpose and no doubt paved the way for later effort, but the real beginning of the industry dates from 1867. In that year a mill was established in an old brewery at Bally and became the famous Bally Paper Mills which for a considerable period were very successful.

The supply of rags for papermaking in Europe and America had long since failed to keep pace with demand. Stimulated as the latter was in England by the removal of duties and taxation on paper and by the growth of commerce and industry there would in normal circumstances have been a danger of a paper famine. The restrictions on the supply of cotton caused by the American Civil War 1861-1865 would have made the shortage more acute, had it not been for the introduction by Routledge in 1860 of Esparto Grass as a material for papermaking. As it was, the circumstances of the time led to the wide-spread adoption of this grass as a material for papermaking and directed the attention of paper makers everywhere to the value of similar tropical and semitropical grasses. The possibilities afforded by the wealth of native vegetable fibres found in India led to the establishment of a number of ventures which are represented by the mills still in existence in this country. The first grass exploited by these mills was *moonj* grass (*Saccharum Munja*) but further experience showed that *sabai* (*Ischæmum Augustifolium*) offered greater advantages. This latter variety is now the staple of the entire Indian industry. It is a curious commentary on the way in which the history of the past disappears from men's minds that, when driven by the necessities of the war, the mills in India again turned to the use of *moonj*, those responsible for the adoption of this fibre as a supplementary raw material actually imagined they had discovered something new. New mills came into existence in 1877, 1881, 1882, 1883, 1890 and 1892. Some of these mills were constantly adding to their productive capacity and competition for markets and raw materials became so acute among them that more than one undertaking including the original Bally mill were driven out of existence.

Stagnation of the industry

Considering the wealth of the native vegetable fibres already alluded to, it is surprising to the ordinary observer to find that after the lapse of fifty years there are yet only nine paper mills in India producing in all about 32,000 tons of paper per annum, while in normal times the country imports yearly a quantity of all classes of paper, including writing paper, estimated at more than double the output of these mills. The natural assumption is that Indian paper makers have not been sufficiently alive to the possibilities of their own industry. This erroneous conclusion has repeatedly led

enterprising investigators to think that India affords unlimited scope for new pulp and paper mills. Consequently many a scheme has been conceived only to fall still-born when conditions and circumstances become better known.

By the time the Indian industry had been inaugurated something had happened which was ultimately to prove most momentous, not only for the paper industry but for the whole world itself. The discovery that timber could be mechanically reduced to a suitable form for papermaking by grinding wood into a finely divided fibrous state in the presence of water (when the product was known as 'mechanical' or 'ground' wood pulp) had attracted attention in America in the early sixties, and in the decade 1870-1880 another form of wood pulp resulting from the digestion of chipped wood with a chemical solution under pressure and at a high temperature began to be produced industrially. These discoveries opened up for the paper maker apparently limitless resources of raw material and the enormous new industry of woodpulp manufacture sprang into existence to revolutionize the world for the paper maker, to change the physical aspect of whole countries by the wholesale destruction of forests, and even, by the impetus given to the printing and publishing of cheap newspapers, to bring about far-reaching changes in the social fabric itself.

The Imperial Institute has recently published a report of the Indian Trade Enquiry on paper materials which describes the important position of wood pulp as a papermaking material in the following words :—

"*Wood pulp as a papermaking material.*—The pre-eminence of woodpulp as a papermaking material is the result of several factors. Enormous and constant supplies of uniform material have hitherto been available, commonly in proximity to abundant supplies of water which allow of cheap transport of the raw material and furnish the power for its manufacture." These great advantages immediately cheapened the cost of paper in the countries which were able either to develop the industry for themselves or to offer a convenient market for the pulp produced. In time the expansion of manufacturing facilities overtook the ever-increasing demand for cheap paper and compelled foreign paper makers to seek extended markets. India, like the rest of the world, benefited by the supply of cheap paper made from mechanical wood pulp, and the growth of the newspaper press of the country is, like the flood of cheap literature

which has afflicted half the world with a mental dyspepsia, a testimony to the thorough way in which this industry has exploited, and indeed ravaged, the forests of Scandinavia and America. Mechanical pulp differs but slightly in chemical composition from the original raw material and contains most of the complex substances natural to wood. Paper made from it is, consequently, not of a durable nature. "It darkens rapidly under the influence of light. It is brittle, even the best of dressings drying out in time, and cracks when folded, tears easily, and in books spoils the temper of the bookbinder and book-collector by refusing to hold the threads unless each leaf is 'framed' or mounted at great expense in a border of sound rag paper."

The uses to which such paper can be put are therefore limited, but the entire Indian demand for paper was and is so very small relatively to the population that the incursion of cheap writing and printing paper, also cheap wrapping papers made from mechanical wood pulp, immediately deprived the Indian industry of all but an infinitesimal share of the one section of the market which particularly offered great scope for expansion. Not only was this so, but the low price at which paper made from chemical wood pulp was also put upon the market made it difficult for the Indian mills to retain a fair share of the business in better qualities; for, although paper made of this pulp does not possess the qualities of a paper made from grass, yet it is a very pure cellulose and has a very attractive appearance. The worst features of the competition forced upon the Indian paper maker by the intrusion of wood papers are the facts that, while in point of price grass paper is unable to compete with mechanical pulp paper, the market for better grades is not only still a very limited one but it demands a large amount of specialization. In attempting to hold their ground Indian mills are driven to undertake the manufacture of many different grades and specialities. What this means can only be appreciated by a paper maker himself. It makes the struggle a very hard one for the Indian manufacturer. He has to be, so-to-speak, a jack of all trades and put his product in competition with the output of those who are masters in their own particular line. The Canadian Trade Commissioner, in a report published some time in 1916, tersely summed up the situation when he wrote "The paper manufacturer in India is unfortunate. He is shut out from his most important market, that for cheap papers, by the high cost of his pulp. The domestic market for good papers

for which his pulp is suitable is not large enough to be worth his while."

Indian mills in the decade prior to the war were thus unable to retain their relative position in the Indian market because of their disadvantages compared with mills situated near or within easy reach of supplies of wood pulp. Wood pulp has proved the dire enemy of the Indian paper maker. Yet he himself makes use of it as it combines to advantage with grass fibres in paper. He can with its aid speed up production and by increased outturn diminish his general overhead costs per ton of paper made. He has thus as it were, drawn strength from his enemy. The unfortunate thing is that he is sometimes obliged to import a great deal more pulp than he can profitably use owing to the failure of the Indian railways to furnish transport for grass supplies.

Dumping

Enough has been said to indicate the unhappy outlook of the Indian industrialist who has the temerity to continue competition with a highly organized Western industry but this note would not be complete without a reference to the notorious 'dumping' which took place in the period prior to the war and has at the time of writing been resumed. When to the powerful factors for economy to which allusion has been made are added the active assistance rendered to European Continental paper makers by their respective Governments for the purpose of extending trade, the low railway rates and other transport facilities granted, the extension of cheap power schemes under the ægis of their Governments and the assistance given by subsidized steamship services, the result is that manufacture and trade are stimulated, production outruns demand and 'dumping' in a distant and unprotected market is the inevitable corollary.

India in the past suffered very badly in this respect from dumping by Germany, Austria and Scandinavia. To-day the most flagrant instances of 'dumping' coming to notice are the result of the slump in trade in Great Britain whose mills are offering paper in the Indian market at prices which they openly declare are below the cost of production. That our Continental friends and late enemies aided by the low value of their currencies are by no means idle is, however, shown by the customs returns and until the long talked of shortage in woodpulp actually materializes or preventive measures are intro-

duced by the Legislative Assembly there can be no hope that this objectionable and ruinous practice will cease.

Value of the Indian papermaking industry

Sir Ernest Low in an article published in the first number of this Journal emphasized the value of industrial improvement and showed how development in this department of the national activities reacts upon others making the people in his own words "fitter for political responsibility and for progress." He added "No nation can command the respect of its neighbour or secure the safety of its citizens that does not fully develop its resources and possess an industrial equipment on a par with that of the rest of the world." There is an important section of Indian public opinion which desires the industrial regeneration of the country and in spite of the retrograde tendency displayed by certain irresponsible agitators the public demand for industrial improvement is increasing, greatly stimulated as it has been by the object lesson afforded by Japan. That country has demonstrated what can be accomplished with Government encouragement by a previously backward Eastern nation. If India is to emulate Japan's example with any degree of success she must build up for herself a complete industrial armoury and become as far as possible self-sustaining. In order to do this she must preserve and encourage such an industry as that of papermaking which so obviously can be, and is being, used as a nucleus for further industrial development.

As has been shown in preceding paragraphs this industry not only offers, like other industries, a market for the products of the mining and metallurgical trades, but it also creates other demands. It calls for the production of heavy chemicals and commodities such as caustic soda, bleach, sulphuric acid, sulphate of alumina, starch, resin, china clay, lime and ochres. The industry meantime is dependent upon overseas trade for most of these articles, but there is no reason why all should not be produced in India except the uncertainty as to the profit or risks involved in creating the necessary industries. Nevertheless some very useful progress has been made. The Government Resin Factory was able, after experiments at the Titaghur Paper Mills, to make its product suitable for use in paper and has thereby found a valuable local customer for a large portion of its output. The lead taken by the Managing Agents of the Titaghur Mills in pioneering and opening up deposits of Indian

kaolin has resulted in much enquiry in this direction and the definite establishment in the country of another new industry. Yet a third industry, and that a most important one, is under development. The manufacture of caustic soda and bleach was described in the Report of the Industrial Commission as "a necessary part of our chemical programme." The first plant in India for the manufacture of these products electrolytically has just been completed at the Titaghur Paper Mills. Thus a definite beginning has been made which may have far-reaching results. It is a question whether, apart from the paper mills, there would be under present conditions any hope of making such an industry profitable, but the pioneering work which these mills are doing will undoubtedly promote the development of India's resources and point the way to further developments. Other investigations are in progress having for their object the recovery of alcohol and other valuable by-products from the waste materials of the paper industry. Obviously were that industry not in existence these advances could not have been made. It may not be out of place here to refer to the part the Titaghur Paper Mills have played in the investigations set on foot by Government with regard to the possibility of utilizing bamboo and various species of grasses for the manufacture of paper pulp. Their experiments conducted continuously since 1912 have been of great value in overcoming the great difficulties of manufacture and of selection of species and have proved that India possesses an enormous store of material suitable for pulp and paper manufacture.

Another point of no small importance is the value of the industry in affording remunerative employment to a large number of persons and thereby tending to raise the standard of living. At present the paper mills themselves directly give employment—according to published statistics—to 5,759 persons, but it is not an easy matter to reckon how many more thousand people depend upon the industry for their livelihood. Leaving out of account the employment indirectly given to those engaged on the railways and in the coal industry as well as to those engaged in allied industries the number of persons directly working for all the paper mills in the collection and supply of raw materials, whether these be grass from the hills and forests or rags and other waste material from the cities and towns, must amount to many thousands.

Regarded merely as a source of supply of paper to meet India's needs the industry is of inestimable present and potential value to

the country. Paper of almost any description can, upon emergency, be produced on the spot and the existence of local mills is not only a guarantee of supplies but exercises a regulating effect upon prices. The mills on the spot are able to meet the varying and peculiar needs of the markets, while the paper produced is particularly suited to withstand climatic effects as it is mainly made from grass and is matured in the country. Partly for this reason Government is a large consumer of Indian made paper and the Indian mills are able to save Government a vast deal of expense in the distribution of supplies. Contracts with Government are entered into on a 'wholesale' basis but a very considerable quantity of the paper sold to Government is delivered in retail lots. In addition to supplying the main Government of India stores and the Government printers the mills make direct consignments not only to the printing presses of the Government of India and provincial Governments, post offices, and railways, but even to the widely scattered District Officers, collectorates, sub-divisional offices and courts—as well as to Army units within and without the confines of India. That this arrangement constitutes for Government an important factor of economy is recognized, though, possibly, not so fully as Indian paper makers would like. It certainly enables Government not only to avoid much expense in handling and distribution but relieves it of the necessity of carrying and financing huge consignments from abroad and heavy stocks in local godowns.

Value of the industry during war

If not fully appreciated during time of peace the importance of the paper industry to this country was certainly brought home to most people during the war and to none perhaps more forcibly than to those responsible for the public services and for the direction of India's military efforts. When the first expeditionary force left India's shores for France it took with it a printing press and a large supply of Indian made paper. Wherever Indian troops were moved, whether to Egypt, Mesopotamia or East Africa, there Indian made paper went to furnish the stock in trade of the Army's administration. to be the vehicle of instruction and information. No doubt during recent years many readers, like the writer, have noticed the familiar Indian imprint on the innumerable Army forms also supplied to Forces other than those from India. Indian mills not only met the demand of the Army on the far-flung field and assisted the

production of munitions but so increased their output that they were able to supply the Indian Government's Telegraph and Postal Services and Railways with supplies far in excess of contract quantities, to assist other Governments as those of Ceylon, the Straits and Hongkong, and at the same time to keep the general business of the country and many of the important newspapers remarkably well supplied with their 'munitions of war.' Japan for a time contributed her quota but had it not been for the Indian mills there would have been a paper famine in India—to say nothing of the probable dislocation of industry and trade and the resulting reaction on India's war efforts.

Costs and prices of paper rose, as did the price of most commodities in the abnormal conditions of the war period, but the Indian paper mills were able to make supplies to the public services at much lower rates for example than those paid by the British Government. A striking testimony to the good sense of the Indian manufacturers and to the generous and patriotic way in which they met the situation is the fact that India alone of all papermaking countries was able to do without the intervention of Government control over the distribution and supply of paper. Bazar prices were enhanced no doubt and from these the Indian mills drew their profits, but even in the bazars prices were lower than in Great Britain and the profits made by the mills were only reasonable in relation to the amount of capital employed and to the risks involved. It cannot be denied that the Indian mills profited when the war put an end for the time being to the campaign of 'dumping' which previously seemed likely to bring the entire industry to ruin, but the profits made were used to furnish the capital required to meet the rise in price of chemicals and materials and to provide for extended manufacturing facilities. A vast amount of speculation took place in the shares of companies engaged in every industry and unfortunately the paper mill industry was not immune in this respect. It was impossible entirely to resist the demands of the new shareholders for returns in some degree commensurate with their expenditure but the mills continued to pursue the policy of building up reserves. Had it not been for this caution their position at the conclusion of hostilities would have been most serious as instead of the expected fall in prices of needful supplies the mills found themselves faced with heavy increases and consequently had to draw largely upon their savings to finance their ordinary working instead of having these available for renewing

machinery which had been worked almost to a standstill during the time of stress.

The amounts set aside for dividends to shareholders, though large in comparison with pre-war figures, are relatively small when compared with the sums which have to be provided to finance the industry, and, indeed, much less than they might have been had the companies concerned taken full advantage of their oppo tunities and charged prices for their product equivalent to those in vogue elsewhere. That they did not do so was due to their recognition of their indebtedness to Government for the support afforded them in earlier years and the reasonable expectation that that support would be continued when the period of emergency was succeeded by the troublous times of peace.

Assistance required by the industry

Protection by means of fiscal arrangements is only one of the forms which Government assistance might take. The industry requires assistance of many kinds. It cannot do without encouragement in the shape of a continuance of orders for paper, the prevention of 'dumping,' and every facility the Forest and Public Works Departments can afford towards the development of forest areas and the extraction of grass. Its immediate and pressing needs are an improvement in the provision of railway transport and favourable treatment in regard to railway rates. Indian Railways are at the present time notoriously ill-equipped to deal with the traffic offering to them and the paper mills are among the worst sufferers from this deficiency. Relatively high rates are levied on their inward traffic, but this is far from being the worst aspect of the situation which is that the mills are debarred from the thorough exploitation of their grass resources. They cannot bring out the supplies which are actually available for the simple reason that the railways are unable to provide wagons for removal of the grass at the proper time. Consequently recourse has to be had to the use of imported wood-pulp not merely to *increase* production but to keep it from falling below a normal level. The ill-effects of this at a time such as that we have just passed through are shown immediately in a rise in the cost of paper, but a more permanent injury arises from the discouragement given to the adoption of measures for the improvement of grass supplies and for the extension of operations generally. The loss to the mills is twofold. Not only is it difficult, wasteful,

and in every way expensive to import and store stocks of woodpulp when capital has already been laid out in the provision of arrangements for local materials, but the cost of the local materials actually received is gravely enhanced by the breakdown in transport arrangements. If stocks at railway stations are not removed regularly and expeditiously they cannot be replaced for the reason that contractors cannot take the risks and expense involved in stacking huge quantities. If this is done it is at the cost of the mills which have to bear the losses and pay the cost of extra storage and double handling involved. Delay in removal of grass from stations dislocates the whole system of collection as it means delay in removal from forests. That in turn means interference with cutting arrangements. The grass season in Northern India begins in November and according to Forest regulations the crop has to be taken out of the forests by the middle of April. It is seldom cleared from the stations before the rains and the results are invariably serious losses from outbreaks of fire in the first place and secondly irretrievable damage by rainstorms during the hot weather and by floods in the rains. The fact that grass at upcountry stations and in the forests is uninsurable at any price speaks for itself.

In regard to outward rates the obvious policy for the Indian railways should be to favour the local manufacture of paper, seeing that for every ton of paper produced the railways get freight on at least ten tons of 'inward' traffic. It will hardly be credited, but it is a fact that as late as 1913 there was an enormous discrimination in favour of the importer. Railway rates on paper from Howrah were considerably lower than from the mills in the neighbourhood of Calcutta while when despatching paper to Cawnpore, Delhi or Lahore the mills had to pay no less than 60 per cent. more freight per maund per mile than did the Bombay and Karachi importer. As an example of this unjust discrimination we may quote rates to Jubbulpore :

	Miles	Rate per maund R.	A.	P.
From Bombay	616	0	9	8
„ Naihati	714	1	3	0

Distance from Naihati 16 per cent. greater than from Bombay. Freight charge increased 100 per cent The railways from western ports still assist the importer to compete on terms of advantage against the mills.

Outlook for the industry

If the industry is again to be thrown into unrestricted and unprotected competition with the world's trade in woodpulp papers it is impossible to take a favourable view of its immediate outlook. The Press of Europe and America has been full of forebodings about the possibility of accessible supplies of pulpwood becoming exhausted and in the latter half of 1920 there was quite a panic on the subject with the result that woodpulp prices soared to unheard of heights. The Committee of the Imperial Institute however declare that "Extreme views as to an actual or threatened critical scarcity of papermaking materials, especially woodpulp, are not warranted," and the recent tremendous fall in prices together with the temporary shutting down of the Scandinavian woodpulp mills shows that this opinion is reflected in manufacturing and trading centres. The cost of fuel and labour in Europe has shown great reductions and consequently a strong revival of overseas competition may be expected and is indeed being felt.

In these circumstances one may ask if an expansion of the industry in India is to be expected. The economic handicap against the Indian industry is enormous. One factor not to be lost sight of is the serious handicap the industry suffers owing to the comparatively small size of the mills. As the Canadian Trade Commissioner pointed out "The four largest mills produce only 96 tons per day between them and the largest and most modern mill produced in 1913 only 32 tons per day." Indian mills *must* manufacture their own pulp and their pulp factories must be of a more economical working size. It is not suggested that they can emulate an American mill with a production of *500 tons or more per day from a single mill* but they cannot afford to lie under the economic disadvantage revealed by the figures mentioned and until matters are improved in this respect their existence must continue to be a precarious one.

For the present the difficulties in the way are enormous. The cost of plant and machinery and the immensity and complexity of the organization needed for successful working are very little appreciated by those outside the trade. Ignorance on vital points has in the past, and may again, lead to the establishment of new ventures which, in their failure, damage the interests of the whole industry and destroy the confidence of the investing public. Seeing that most of the capital invested in the local industry now belongs to the Indian public it would be very serious if history were to repeat itself

in this respect and it is to be hoped that all who have at heart the welfare of the country and of its industries will strive by co-operation and a real appreciation of the needs of the situation to find means to set this industry once and for all upon a firm permanent basis of security and prosperity.

A. R. BARBOUR

THE PROBLEM OF INDUSTRIAL FATIGUE IN INDIA

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The need of studying the causes of industrial fatigue was forced into prominence during the war, largely owing to the necessity of utilizing to the best advantage the energies of those engaged in the output of munitions. Though the war is over, the need still remains, if production is to be maintained at a satisfactory level.

Results obtained by studying the problems of industrial fatigue have already shown that the task of the worker can be made appreciably easier while, at the same time, his output can be increased with less expenditure of energy. There can be little doubt that employers and employees in India would benefit considerably if a study was made of these results and if similar enquiries were set on foot. In this paper attention will accordingly be drawn to what is being done in other countries, more especially in England, and some suggestions will be made of possible lines of investigation in this country.

When research was first started a great many enquiries were based on the assumption that there was a close causal connection between the rate at which accidents occurred and the onset of fatigue. Investigations undertaken by Dr. Vernon, for the Health of Munition Workers Committee, have, however, demonstrated that, though the accident rate and the rate of output may vary from hour to hour, it is wrong to conclude that fatigue is the primary factor involved in the causation of accidents, as speed of output, bad lighting, etc., have also a very direct bearing on it. At the same time, it is admitted that the presence of undue fatigue, especially in the case of women employees, may be detected by studying the accident rate and that a shortening of hours has been found to lessen the rate appreciably.

Having shewn that fatigue cannot be measured by examining the accident rate alone from hour to hour, the next step was to

discover, if possible, some other tests. The most obvious test was that of output, but in that case also it had to be recognized that other factors besides fatigue should be taken into account. A well known experiment, based on a study of output, is that made by Messrs. Mather and Platt at Salford in 1893. They wished to ascertain whether hours could be shortened without detriment to the work. They accordingly reduced working hours from fifty-three to forty-eight and found that, not only was production increased, but that much less time was lost by the workers, who responded by "increased cheerfulness and brightness" to this relaxation of their toil. This investigation convinced Sir William Mather that the best results were obtained "by working in harmony with natural law" and that "the most economical production is obtained by employing men only so long as they are at their best." [1 *]

Recent research has endeavoured to discover these natural laws and to show how industrial work may best be carried out in harmony with them. This means that the nature of fatigue, its causes and effects, have first to be studied. It was not easy to discover a satisfactory definition of the term 'Fatigue.' The most comprehensive definition is that fatigue is the "sum of the results of activity which show themselves in a diminished capacity for doing work."[2] The cause is activity and the measure of the resulting fatigue is a diminution of output, although, for all popular purposes, the bodily sensations accompanying it are generally taken as indicating its presence. Though these sensations do serve as a useful empirical guide, experiments have shown that they do not indicate at all correctly either the extent of the fatigue or the part of the body chiefly affected. The results of these experiments are given concisely in an extremely valuable book that has recently been published.[3] There it is clearly shown that fatigue is situated primarily in the central nervous system, the brain and spinal cord where impulses originate and are distributed, and possibly, in a secondary manner, in the nerve end organs. The muscles are not affected to the same extent, owing to the failure of the impulses to reach them before they have reached the stage of exhaustion.

The problems of industrial fatigue. are, consequently, primarily concerned with fatigue in the nervous system. But, just as the muscles are themselves protected from over-exertion, mental strain

* The numerical references in this article are to the bibliography.

is also lessened in a similar way. For, while it is possible with certain limits to control one's ideas and to discard others that are irrelevant to the purpose in hand, failure to inhibit extraneous activities compels one ultimately to relinquish one's task and thus gives the much needed rest. But, in so far as this second form of inhibition is more within one's own control, it is comparatively easy to break down this protective barrier and to bring about 'overstrain' which is the pathological expression of continued fatigue. Overstrain is, in consequence, to be noticed more often as an accompaniment of mental exertion than as a result of muscular work.[4]

This process of inhibition, whether it affects the muscles or one's mental processes, brings about involuntarily a period of inactivity. During this period of rest, provided that it is of sufficient duration, the products of activity are swept away. But if this period is too short, then accumulated fatigue will develop and will result in a diminished capacity for work. To determine how work and rest should alternate is one of the most important problems connected with industrial fatigue. Closely allied to it is the study of rhythm, which seeks to discover the natural rhythm of the worker, so that he shall not suffer by being asked to keep pace with a machine to the speed of which he cannot adapt himself. Thus we see that fatigue is the necessary sequel to activity, measurable by a diminished capacity to do work and requiring a period of rest to remove the products engendered as a result of activity, and needing, too, a supply of food to build up again the energy that has been expended.

From the point of view, then, of industrial work, fatigue should be recognized as having an important effect on output. And, just as those who are interested in the prevention of illness are chiefly concerned with keeping fatigue within wise limits because they known that it "has a larger share in the promotion or permission of disease than any other single causal condition," so also the time has come for recognition of the truth of the statement that, in order to secure the largest output, fatigue should not be allowed to pass definite physiological limits. In short, the conservation of health and the production of wealth go hand in hand and can be promoted by the adoption of exactly the same methods.

We may now briefly examine some of the causes that contribute to industrial fatigue. The most potent of these causes is generally the work done, but the conditions under which it is done frequently aggravate the consequences and thus have a very direct bearing

on output. A reference will be made later to the enquiries made on the effects of temperature and humidity. Deficient lighting, unnecessary noise, long hours of work, inadequate facilities for rest, also have their share in reducing the capacity for work. Then, too, the internal organization of the factory has a very direct effect. If mental worry supervenes on manual toil, a still further drop in output may be expected; a bullying foreman, uncertainty as to how wages are calculated, a feeling that one's interests are being neglected, an unsympathetic way of being taught one's job, these are some of the factors that contribute to discontent and bring about a lack of interest in the work. Further, if no suitable arrangements are made enabling the workers to eat their midday meal in comfort ; if there is no place to which they can go if they meet with an accident or feel ill, then gradually their general health is lowered and their capacity for work also becomes lessened.

While the employer is generally responsible only for the actual factory conditions, there are other factors also which affect the health and well being of his employees. Unsatisfactory housing conditions, the distance that has to be traversed between home and factory, the lack of facilities for recreation, all tend in the same direction, and in many cases result in the worker either giving up his work altogether or doing it with less and less energy.

These are some of the external conditions producing fatigue. As far as the worker is concerned, they are reflected in a lessening of output, an increasing loss of time by idling during working hours and in absence from work for entire days. Sickness may supervene, or the fatigue and discontent arising as a result of all these causes may contribute to a heavy labour turnover, (*i.e.* a high rate of loss of employees), so characteristic of many industrial establishments.

Attempts to lessen fatigue due to factors arising out of the conditions of employment have resulted in many factories in England and in America starting what are commonly known as 'welfare schemes.' Special appointments are made on the factory staff of persons whose duty it is to enquire into working conditions and to make suggestions to the management. The contentment of the worker is regarded as an important asset, and care is taken to see that his physical needs are supplied and that his mental attitude to his work is not allowed to develop into boredom or active discontent.

The more scientific aspects of the problem of fatigue have necessarily to be dealt with by trained experts. For this purpose an

Industrial Fatigue Research Board has been founded in England. To this is attached a group of investigators. This Board is a development of a "Health of Munition Workers Committee" which carried out research, between 1915 and 1917, into the effects of long hours of work upon output, upon accident incidence, and upon sickness and lost time in munition factories.[5] On the disbandment of this Committee at the end of 1917, the Medical Research Committee and the Department of Scientific and Industrial Research, with the active encouragement of the Home Office, decided to form a Committee to investigate the subject of industrial fatigue on more comprehensive lines by embracing all classes of factories within its scope of work.

Enquiries have been started in the iron and steel trade, in the cotton industry, in laundries and in the boot and shoe trade. These particular industries have been selected, either because of their importance, or because of certain information that was required as to the best conditions of work.

This Board has already published several reports shewing what has been achieved and the lines upon which further enquiries are being conducted.[6] These reports may, with advantage, be studied in detail by those interested in the particular problems involved. In this paper it is only possible to refer to a few of those which may be of more general interest.

Before passing on to a brief description of the enquiries selected for special reference,[7] it may be as well to refer to those that are still under investigation. A detailed research is being conducted by Mr. S. Wyatt into fatigue in the cotton industry. Weaving has been selected as the process most directly affected by the human element. Automatic 'pick recorders' have been affixed to a large number of looms which will be run on uniform material for about one year. Throughout that period hourly readings of these records are being taken. It is hoped in this way to trace, not only the course of the fatigue, but the point at which it begins. The effect of heat, noise and humidity on fatigue is also under examination and a time study of the weaving process is being made. Further, as output is also affected by temperature and humidity as well as by fatigue, the Research Association of the Industry has been invited to undertake a research on the effects of different degrees of humidity on the weaving of the cloth concerned. The results obtained

should be of special interest in this country where the textile trade is of such importance.

A study of individual differences in output in the cotton industry, the results of another enquiry also by Mr. Wyatt, serves to emphasize the necessity of selecting men according to their capacity for the work in hand. This selection cannot, however, be carried out unless suitable psychological tests can be devised, whereby it will be possible to differentiate those that have the necessary capacity from those that have not. Another investigator, Mr. Muscio, is, accordingly, devoting himself to this.

The results of the researches made by Dr. Vernon and Major Greenwood into the causation of accidents have demonstrated the necessity of examining the problem still more closely. There appears to be a special tendency to accidents among certain individuals who, though exposed to exactly the same risks as the other employees, suffer from a great many more accidents. The reasons of this predilection must be studied in order to prevent such individuals from being exposed to undue risk.

The attempt to find a satisfactory psychological test for fatigue has been abandoned. The Board have decided to try to discover in its place a physiological test, and Mr. McSwiney, lecturer in Physiology in Leeds University, has undertaken to study the possibility of using the wink reflex and changes in the pulse-rate as media for a satisfactory fatigue test.

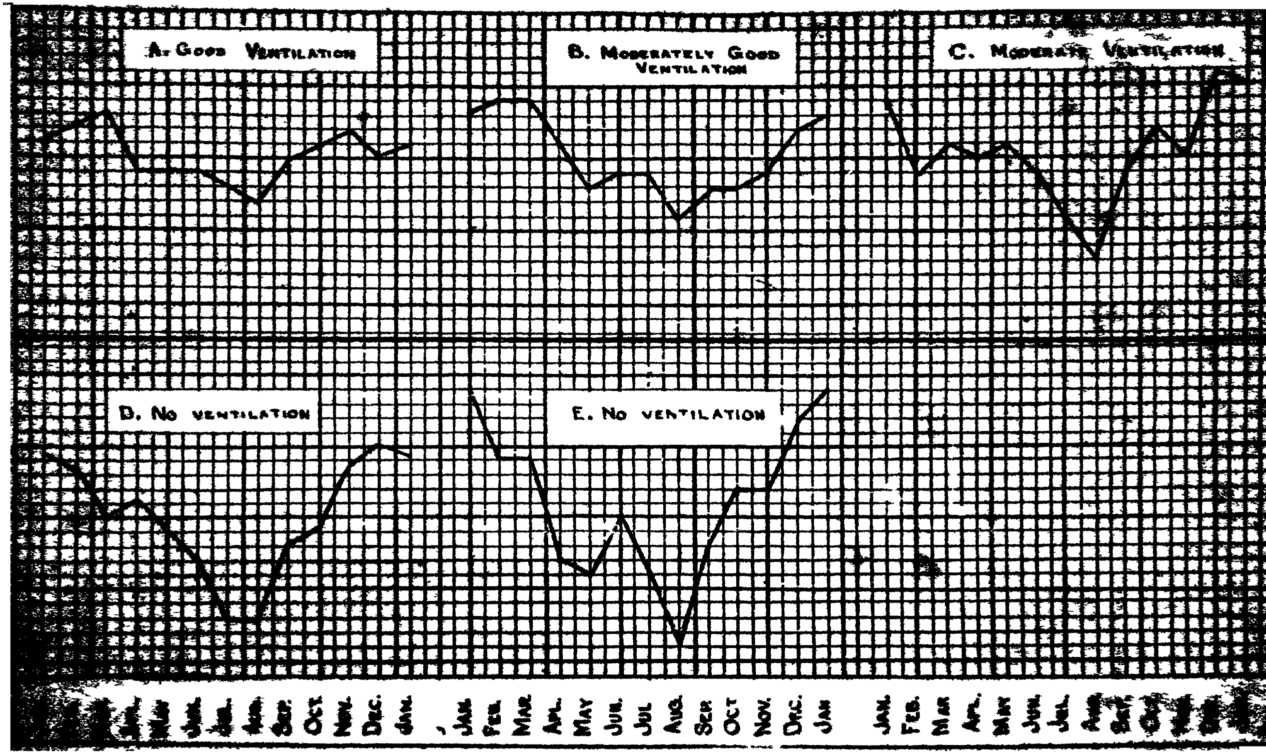
In order to persuade factories to keep records on similar lines, a standard system of records relating to sickness, lost time, labour turnover, accidents, etc., was drawn up by one of the investigators.[7a] It was hoped that by this means data could be collected from several factories and that the results would be comparable.

We may now turn to the completed reports selected for examination and commence with an interesting account by Dr. Vernon of the influence of hours of work and of ventilation on output.[8] The effects on output of (1) shifts of different length and (2) different systems of ventilation were compared, and the result was reached that the hourly output increased by about 10 per cent. when shorter shifts were worked and that, allowing for the fewer hours worked, the total output was about 8·3 per cent. greater. The effect of ventilation on output is clearly shown by a series of graphs which are reproduced here.

The importance of good ventilation, not only from the point of view of output, but also from that of health, can scarcely be over-estimated. Its effect on health has not yet been thoroughly examined but this will doubtless be done. Dr. Vernon has come to the conclusion that its effect on output is very appreciable, and thinks it probable that the installation of a thoroughly efficient system of ventilation in an ill-ventilated factory may increase the average output by 12 per cent. or more.

We may now draw attention to the results of another report which aroused considerable public interest both in England and in the United States. The Industrial Fatigue Research Board were invited to enquire into a remarkable increase in output achieved at an iron foundry as a result of improved methods of work.[9] Dr. Myers undertook to enquire into the matter and found that the statements made by the firm were substantiated in all cases. As a result of a judicious combination of movement study, training of workers, improvements of appliances, shorter hours of work and higher wages, an output of 20,000 plugs weekly was obtained, whereas the estimated capacity of the plant was only 3,000, while another firm with a larger plant found it difficult to maintain an output of 5,000 plugs. Even supposing that there was some error in the estimate, the fact that these works with a smaller plant produced four times as much as another factory engaged on the same work indicates the presence of some important causes. It was not possible to estimate numerically the effect of some of the causes already cited, but the careful study of movements and the elimination of all unnecessary actions, combined with careful training, produced the astonishing result that the hourly output of certain machines increased by nearly 284 per cent. Other employees engaged in manual work increased the output of their work as a result of training from 80 to 141, 151, 143 and 173 respectively. In this case the need of these plugs as war material justified the manager appealing to his men to increase their output. It was realized, however, at the same time, that their active concurrence and good will should be obtained. The whole system was explained to them and the promise that was made, to reward increased output by higher wages and shorter hours, was faithfully kept.

We obtain a very clear exposition of the method of enquiry in the report entitled *A study of the output in silk weaving.*[10] Though the actual results obtained in this case were not, perhaps,



EFFECT OF VENTILATION ON OUTPUT

as important, they furnished valuable indications regarding the necessity of studying efficiency, time-keeping, etc. Incidentally, this enquiry elicited a very interesting fact concerning the effect of daylight on output. As a result of his observations, Mr. Elton has come to the conclusion that "every unnecessary hour under artificial light means a direct loss of production and makes the task of the worker more difficult than it need be." He quotes the recommendations of the Departmental Committee on the "Lighting of Factories and Workshops," shewing how additional daylight may be secured in overshadowed rooms. He also gives useful suggestions regarding the utility of keeping records relating to absence from work and the reasons for it, and at the same time draws attention to the need of keeping a record shewing the amount of time lost through lack of foresight on the part of the management.

We have so far referred principally to the work done in England on the subject of fatigue, but the pioneer work done in America should not be overlooked. Dr. Josephine Goldmark, in her well-known book entitled *Fatigue and Efficiency*, published in 1912, drew attention to the economic results of fatigue and advocated several practical legislative reforms. The name of Taylor has long been associated with scientific management. Although the methods he recommends are open to abuse much credit is due to him for bringing into prominence the need of studying the human element in production. Since his time a mass of literature on scientific management has been published in America. There is also a Committee on Industrial Fatigue in the United States. It is subordinate to the Council of National Defence and co-operates with the Public Health Service in investigating conditions of industrial work. The United States Department of Labour also issues publications dealing with fatigue and kindred subjects.

In France a Comité d'Hygiène has recently been appointed by the Institut d'Hygiène Sociale and the Direction des Récherches Scientifiques, jointly, to make similar enquiries.

In Belgium special attention has been paid to the necessity of learning the correct method of work. A very interesting account is to be found in a book written by Dr. Josefa Ioteyko.[11]

Enough has been said to indicate the world-wide recognition of the importance of the subject of industrial fatigue. The immediate problem is to consider what can be done in India to stimulate an interest in the subject The good will and co-operation of the

employers is essential, if experiments are to be made under working conditions. The best persons to undertake the enquiries are undoubtedly those who are interested in the employees and who have received some training in experimental psychology and in physiology. Funds will obviously be needed. These have been provided in other countries largely by the State and to some extent by Trade Associations. Enlightened employers in this country will also, probably, be willing to contribute towards the expenses.

Assuming that the desirability of enquiries is accepted, some possible lines of investigation may now briefly be indicated. It must be admitted, at the outset, that the time is not yet ripe for elaborate experimental work. This should not, however, preclude the possibility of starting simple investigations and keeping records of output, sickness, labour turnover, accidents, etc., for purposes of scientific analysis and study. Very important results may quite possibly be achieved by the introduction of simple alterations in the conditions of employment. There is, at present, no hereditary industrial class of workers in India. Industrial labour has hitherto almost entirely been recruited from the ranks of agricultural workers. Employees, accordingly, seem to find it extraordinarily difficult to adapt themselves to such a very different environment. Every slight modification, introduced to make conditions more tolerable, will, therefore, doubtless have very appreciable results, both on the health of the employees and on their length of service in the factories. At present the rate at which the workers leave is a very serious drawback to the industries concerned. Nor can this process be carried on indefinitely. It is true that the present supply of labour, though not plentiful, is generally sufficient for all immediate requirements. Circumstances may change, however, and no country that hopes to increase her industries can afford to neglect any measures that will render employment progressively more attractive.

As a preliminary measure, it would be well if employers would begin by keeping individual records relating to their employees. The name of the employee, approximate age, native place, etc., and the date of engagement should be recorded. When he leaves an attempt should be made to find out the cause. His reason, or supposed reason, should then also be added to the card. From this card-index, in the course of time, an employer should be in a position to make a very fair estimate as to the changes that take place in

the factory personnel and the probable causes. This should enable him to eliminate, to some extent, some of the causes contributing to a heavy rate of loss of employees.

Having arranged to keep records of this kind, the employer may well turn his attention next to a study of output during different seasons of the year to see how far it is affected by temperature and humidity. Such an enquiry would probably suggest the need of improved methods of ventilation and humidification. Further, if the output of individuals is studied, as well as the gross output, then it should be possible to discover those who are suffering from undue fatigue or from any other hindrances to their work.

An analysis of output records, however, will not, by itself, yield very fruitful results. They should be studied in conjunction with the time-keeping records, as fatigue or sickness almost immediately results in absence from work. In factories where a doctor is employed to look after the health of the employees, a careful record of all sickness cases that come to his notice is probably maintained by him. An analysis of such cases should help him to discover how far the work is a contributory cause. This should enable the management to eliminate any unsatisfactory features attaching to the employment. A record of all accidents should also be kept and a study should be made of their causes.

These are but a few tentative suggestions, shewing how simple investigations may, at first, be started. Many employers, however, may not be willing to adopt them, but, if the attempt is made by even a few and the results published, there is little doubt that the value of these results will prove to be so great that many will be willing to benefit by them, and will, in their turn, help to examine the problems connected with industrial fatigue.

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A NOTE ON HAND-LOOM WEAVING IN INDIA

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Acquainted as most people are with the past fame of India as a cotton manufacturing and exporting country, and with its present dependence on foreign countries for one of the necessities of life, namely clothing, any suggestion for the improvement and development of this ancient handicraft ought to be of interest to those responsible for the well-being and advancement of Indian industries. It is really a remarkable thing that, notwithstanding the enormous importance of this industry, no serious attempt seems to have been made up till now to improve the economic condition of the weaver supported by it. It is not the object of this note to recapitulate the various stages through which the hand-loom industry has passed. Suffice it to say that India, one of the homes of cotton, spun and wove it on *charkhas* and hand-looms for centuries and clothed, besides herself, most of the civilized nations of the world with her products. The same India has now to import cloth worth about 60 crores of rupees a year to clothe herself. This state of affairs may be due to the very high rate of consumption of clothing in recent years resulting from the higher standard of comfort and the increasing population of the country; for our production of cotton cloth, instead of diminishing, has been on the increase. During recent years a large number of cotton spinning mills have sprung up in the country and large quantities of raw material in the shape of yarn have been made available for the hand-loom weaver. The only deplorable fact regarding hand-loom weaving is the gradual disappearance, amounting in some places to the total extinction, of the artistic fabrics which used to be prized so much in the past.

Importance of the industry

The magnitude and importance of this industry cannot be better realized than by a reference to our import and export trade in tex-

tiles and our production both in the mills and on the hand-looms. The figures quoted here have been arrived at after striking a five years' average, to make allowance for temporary variations in the import and export trade and various local conditions. To speak in pre-war figures, the net imports of cotton goods were 2,557 million yards, against 1,015 million yards woven in the Indian mills and 1,186 million yards woven on the hand-looms. Thus, our normal consumption of clothing may be estimated to be very nearly 5,000 million yards, worth about 220 crores of rupees at present market rates. Owing to economic distress and abnormally high prices ruling as a result of the war the purchasing power of India was crippled ; nevertheless she imported annually 1,462 million yards (net) and consumed annually with her own production of 1,363 million yards from the mills and 979 million yards from the hand-looms, 3,803 million yards of cloth in all, during and after the war. It may not be out of place to mention here that our mills spin about 663 million lb. of yarn annually, of which 133 million lb. are exported to neighbouring countries. Against this we have a net import of 27 million lb. of yarn, mostly of the finer counts, from outside. Indian mills are able to export only 182 million yards of cloth, against 1,462 million yards imported annually.

The following figures of imports, exports, production and consumption may be of interest :

	1913-14	1919-20	Average for five years ending 1914	Average for five years ending 1920
		Million yards		
Imports of cloth from outside .	3197·1	1080·7	2616·6	1547
Exports of foreign cloth	62·1	88·6	60	85
Net imports for use	3135·0	992·1	2556·8	1462
Total Indian mill products	1164·3	1639·7	1105·5	1545
Exports of Indian cloth .	89·2	196·6	90·2	182
Net production available	1075·1	1443·1	1015·3	1363
Estimated production from hand-looms*	1276·8	610·3	1196	978·7
India's annual consumption of clothing	5486·9	3045·5	4758·1	3803·7
		Million lb.		
Exports of Indian mill yarn	199	155	193	133

* These figures are obtained by allowing 4½ yards of cloth for every pound of yarn manufactured in the Indian mills and 6 yards for finer yarn imported into India and not exported.

The tastes of the people are rapidly changing as the standard of comfort rises, and there is an increasing demand for finer qualities of yarn and cloth for which at present we have to look to foreign countries for supply. We cannot, at least in the near future, expect the Indian mills, whose hands are already full with the production of coarser qualities, to manufacture these; for, in the first place, India cannot produce long staple cotton necessary to spin yarn of finer counts and, secondly, India has not yet acquired that skill and ability which Lancashire has achieved in the course of the last century and a quarter. While it is impossible to dogmatize about any of the problems resulting from the war, yet one can feel confident that, before long, the consumption of clothing will return to something approaching the pre-war normal, and that the average annual increase in our requirements may be expected to be no less rapid than it was before the war. For, apart from the fact that cloth is wanted in continually increasing quantities for our backward communities, a large number of our aborigines are yet to be clothed. Even taking the lowest estimate, India's demand in the course of the next ten years is likely to increase to 5,000 million yards of coarse cloth besides 2,500 million yards of finer qualities, or a total increase of 50 per cent. in all. How are we to meet this situation? We admit that we shall have to import for some time yet the finer varieties of cloth as we do now, but there is no reason why we should do the same in the case of coarser ones. India ought to be able to meet her own demands so far as these qualities are concerned, for she produces nearly 25 per cent. of the world's total output of cotton and sends out practically half of this to Japan and Germany besides other countries, only to get a great part of it back in the shape of yarn, cloth and other finished goods. The rest is used to a great extent to compete with Indian exports in foreign markets It is unnatural that this country should continue to export for ever this valuable raw material and import goods made out of it, and it is imperative that India should, therefore, find some means of meeting this ever-increasing demand for cloth.

Advantages of encouraging hand-loom weaving

There are many good reasons, into the details of which the author does not propose to enter, why it would be unwise to encourage actively the starting of a large number of weaving mills in the country. It is a matter of common knowledge to those who have

had occasion to study the economic and social condition of factory workers both in the west and in the east that factory life plays great havoc with the well-being of a community. Indian conditions, especially of family life, and the temperament of an Indian artisan, are such that the latter has a strong aversion to factory life, and unless an artisan is forced, usually by poverty, he always prefers to go back to his lands in the village and lead the peaceful and morally clean life of an agriculturist. The present exodus of the Bombay mill worker, who is an agriculturist first and an industrial labourer afterwards, in the months of April and May to the coasts of Ratanagiri and Malwan for four to five months in the year is to be attributed to these causes which prevent the formation of a purely industrial class in India. It is a battle between poverty and economic necessity, on the one hand, and morality and spiritual necessity on the other, and the battle is not yet decided one way or the other. Let us hope that it will not be finally decided in favour of the wrong side. The mills of Bombay and Ahmedabad have experience of this, and the shortage of labour and its fleeting character are their constant complaint. Looking at the present situation, when the mill hands are constantly restless with strikes and lockouts caused by demands for higher wages and shorter working hours, the village weaver has a comfortable time at his loom and makes his best out of the unusual prosperity prevailing in the textile trade.

After these prefatory remarks it would not be difficult to visualize the advantages of encouraging hand-loom weaving in India and to realize the ample possibilities it has of development. For one acquainted with the marvellous improvements effected of late in textile machinery and the enormous production which a mill operative is capable of turning out, the idea of a hand-loom successfully competing with an automatic power-loom of the present day may at first sight look ridiculous. But still, the writer makes bold to suggest from his experience of this cottage industry that it is not only capable of resisting the onslaughts of the organized mill industry, but is quite fit to carry the war into the enemies' camp itself. The very fact that this handicraft, instead of succumbing, has been steadily making progress, as evidenced by the ever increasing consumption of yarn, ought to be enough to convince the doubter of its wonderful vitality and ability to maintain its place among the manufacturing industries of India. The belief that the cost of manufacture in a mill is considerably lower than that of hand-loom

manufacture is disproved by the figures, given below, for 1914. These figures refer to the manufacture of cotton coloured *saris* (8 yards ×42 inches) of average 20s counts of yarn which nearly 75 per cent. of the hand-loom weavers weave.

Place of manufacture	Weight of cloth		Total wages paid			Cost of production per lb.			Value of cloth		
	lb.	oz.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
Power-loom, Bombay Mill A	2	2	0	9	0	0	4	0	3	7	0
Power-loom Bombay Mill B	1	8	0	7	7	0	5	0	1	14	0
Hand loom Mysore (single shuttle)	2	0	0	9	6	0	4	9	2	12	0
Hand-loom Mysore (double shuttle)	2	4	0	12	6	0	5	8	3	4	0
Hand-loom Dharwar (coarse silk border)	2	12	1	1	0	0	6	2	6	4	0
Hand loom Sholapur	1	12	0	7	6	0	4	3½	2	4	0

Thus, the minimum cost of manufacture in the case of mills is four annas three pies per pound of the article made, against six annas two pies representing the maximum cost of the hand-made article. In the case of grey goods, the cost of production in the mills during pre-war days was as much as two-and-a-half annas per lb. (including, on an average, 20 per cent. of size) and this must since have doubled; for the cost of machinery and buildings in India has gone up three times and that of coal two-and-a-half times. The labour charges have doubled with a proportionate increase in the cost of mill stores. In the case of hand-loom weavers, however, the wages in most cases have not gone up above 50 per cent. Thus, even in grey goods the difference in the cost of manufacture does not exceed a couple of annas per pound of cloth, a figure which works out to 5 per cent. of the current value of the finished article. This 5 per cent will be far more than wiped away, and the advantage in the competition will go entirely to the hand-loom weaver, if only his purchasing and selling power is properly organized.

Before proceeding further, the writer is tempted to pause here to mention the extent to which the new conditions resulting from the

effects of the great war in Europe have been brought to bear on the economic life of India. He proposes to instance the hand-spinning of cotton in Bihar, in particular, where this domestic handicraft has not died out. As a result of his inquiries during a recent tour he found that this industry is showing signs of revival and that hand-spun yarn is being used for weft by weavers in the villages. They find the hand-spun yarn cheaper than the mill yarn of similar counts by about six annas per pound. At the time of the inquiry, hand-spun yarn of about 10^s to 12^s counts was being sold at eight annas per pound, while the price of mill yarn was fourteen annas and that of cotton five annas per pound. The cost of hand-spinning, namely three annas per pound, compares favourably with the present mill cost of two to two-and-a-half annas per pound. The fact that the mill-spun yarn is much superior in quality and that the weaver has, therefore, to depend on it for his warp cannot be disputed; for the cotton in a spinning mill is first well carded and the fibres are drawn parallel in a number of draw frames, so as to give the yarn uniformity and strength. Owing to deficiency in these qualities, apart from deficiency in weaving quality due to soft twist, hand-spun yarn takes about four times the labour to weave it into cloth. In the weaving of the '*kokti*' cloth of North Bihar, the yarn for which (about 40^s counts) has been spun for centuries by hand from a special type of brown cotton, as many as ten days are taken for weaving a piece of sixteen yards. Owing to the existence of a certain class of people who attach a certain sanctity to this particular quality of cotton, it pays the weavers to manufacture the cloth and sell it at a cost of Re. 1-8 per yard, a price twice as much as is paid for a mill-made cloth manufactured from yarn of similar counts.

High price of hand-woven cloth

Why then do we find that the hand-woven cloth is selling at a much higher price than mill-made cloth when the cost of manufacture of both is practically the same? This is because the hand-weaving industry is not organized as is the mill industry. The difference in prices represents the profit of a host of middlemen, who, both in the retailing of yarn and in the sale of cloth, make enormous profits at the expense of the weaver and consumer. In the case of the power-loom weaver, the yarn is spun for him in the same mill to suit his requirements, and the cloth is sold through agents who can afford to charge

a very small percentage of profit, owing to the large bulk of goods they handle, with the result that the cloth is sold to the consumer at a cost not exceeding 10 per cent. over the mill rate. Such a facility is denied to the hand-weaver, who pays for his credit purchases of yarn as much as 25 per cent. over the wholesale rate. His finished goods pass through at least two dealers, each of whom charges about two annas per rupee for his share of the profit, and thus the price of hand-woven cloth is enhanced by another 25 per cent.

Primitive methods of the Indian weaver

Another great handicap of the Indian weaver is his primitive methods. Although he has taken very generally to mill-spun yarn, he uses, as a rule, the same pit-loom which his remote ancestors have handed down to him. The cotton yarn, as it comes from the yarn dealer in hanks, is put on a swift and is wound, one thread at a time, on a bamboo spool of conical form. It is then warped to a length of 9 to 10 yards on a frame or on the wall or the ground. In the latter case the warper walks about 8 to 10 miles to warp sufficient ends for one warp. The warp so prepared is steeped over night in size and is spread and stretched out in the open to dry next morning. At this time it is well brushed, the lease rods being moved forward to prevent the threads sticking to one another. When the warp is ready it is twisted on to the remnant of the old warp in the loom. In some places the healds are knitted on the loom for every warp put on it without disturbing the bamboo reed which is generally used. These healds are of unvarnished twine with two loops and without an eye in the centre. The Indian weaver uses a heavy wooden board for his sley and throws the shuttle by hand across the warp through the shed at 40 to 50 picks per minute. The warp is stretched out to a length of about three yards, depending on the length of space available to him in his cottage. After weaving this length, he stretches out another from the warp bundle until he finishes the length of cloth he has to weave. During weaving the weaver separates the warp ends at the back of the loom and moves the lease rods forward for every length he has to weave at a time. The fly-shuttle sley, dobbie, warp rollers and other improved appliances introduced into England and other European countries a century and a half ago were practically unknown in India, outside the power mills, until the beginning of the 20th century, when, chiefly through the agency of the Government departments, they began to be intro-

duced among the weaving community. But even now the vast majority are unacquainted with them. There are roughly two million adult male weavers in India at present. How many of these actually weave on the hand-loom for a livelihood it is difficult to say. Some, but only a relatively small number, have given up their trade or else work in the power mills. Others, and these form a fair proportion of the whole, are cultivators as well as weavers. Probably it would be a safe estimate to say that there are 1,800,000 hand-looms in India in operation to-day. As the annual production of hand-made goods is about 1,000 million yards for all India, the average production per loom is, therefore, only 555 yards per annum, or 1½ yards a day. The general introduction of the fly-shuttle loom alone should increase the output by at least 50 per cent., and probably by nearly 100 per cent.

Necessity of organization

Yet, in spite of present adverse conditions the cottage weaver, with a poor raw material spun by his competitor, the mill owner, and with his crude appliances combined with equally inefficient methods of work, manufactures and sells annually nearly 1,000 million yards of cloth worth over fifty crores of rupees in competition with the power mills in the open market. If his trade be organized, so as to secure for him at least a portion of the profits of the trade and he himself be armed with the latest labour-saving appliances, which can, without extra cost or effort to himself, double his output, and be supplied with yarn of the quality now used by the power-loom weaver, it may not be long before he will be in a position to capture many of the markets which are now monopolized by the mills. While the hand-loom weaver has yet to explore his field, the textile machinist has practically exhausted his resources to cheapen the cost of manufacture. Such are the prospects before the Indian weaver who has come out successfully from the severe test of the machine age.

Before coming to any conclusion let us consider the possibilities of starting small village factories, in which the economic factors are more favourable than in a purely cottage industry. There is a large number of such factories flourishing on the coasts of Malabar and South Canara. But attempts made to start factories on similar lines in other parts of India have generally failed, even in the hands of able business men with enough capital to back them up. The

failure may be due to three causes, namely, (1) want of sufficient technical training on the part of those responsible for supervision, (2) difficulty of securing skilled weavers from the cottages to work in a factory under discipline, and (3) absence of suitable labour-saving appliances for preparatory processes. These three factors are absent on the west coast. The German missionaries, who first started the factories, after converting to Christianity a number of non-professional people, trained them both as supervisors and weavers. But as these were accustomed to weave coarse goods, such as checks, bedsheets and towels, which did not require much in the way of preparatory machinery, they were not found of much use in factories where indigenous patterns were attempted on fly-shuttle looms. In the absence of preparatory appliances, the factory owner was unable to compete successfully with the cottage weaver, whose dependents prepare the yarn for his loom at absolutely no cost; for he had to adopt the same slow laborious methods of the weaver and pay heavily for them, besides meeting a host of overhead charges incidental to the factory system of work. Thus, the small profit accruing from organized business was lost in the increased cost of manufacture. At present, however, some efficient hand machines for winding, warping and sizing, which are beyond the reach of an average cottage weaver owing to their initial cost, are available, and it may pay a capitalist with the necessary training to run a small factory, provided he secures skilled weavers or trains a batch of non-professional people for his work.

Conclusions

We can now draw the following conclusions from what has been said before :—

(a) The total consumption of clothing in India is likely, in the near future, to be 5,000 million yards of coarse cloth per annum, besides the finer qualities which have to be imported to the extent of 2,500 million yards.

(b) Only half of the former quality is now produced in the country, 1,500 million yards by the mills and 1,000 million yards by the cottage weaver.

(c) Hand-loom weaving is an industry of undoubted importance to India and offers practically boundless scope for improvement. The general belief that hand-woven goods cannot compete with machine-made goods is erroneous.

(*d*) Active encouragement of the starting of a large number of weaving mills for the production of this anticipated deficit may not be in the interest of India. On the contrary, the number of our spinning mills ought to be doubled as our requirements in yarn will increase in that proportion.

(*e*) As the hand-weaving industry has not, so far, received sufficient attention either from the public or the Government, a vigorous policy for the rapid and satisfactory development of hand-weaving should be pursued on the lines recommended by the Indian Industrial Commission.

The educated classes have, up till now, usually taken to the learned professions, leaving the crafts to the care of the illiterate mass which is thoroughly conservative and distrustful of outside interference. But the salvation of the country lies in the general uplift of these people. This is possible only when the Government and the public-spirited leaders of the country co-operate to overcome these shortcomings and to improve the cottage industries, and thus enable the Indian people to take their proper place among the industrial nations of the world.

Suggestions for action

This note on hand-loom weaving may not be considered complete unless some definite suggestions are made as to the lines on which the work already started might be carried on with advantage. A programme of work has already been recommended by the Industrial Commission, and the following paragraphs are intended only as an elaboration of their recommendations.

Technical help

I. *The establishment of a central textile institute for the whole of India for the investigation of general questions affecting the hand-loom weaving industry of the country as a whole and of such subjects as the rearing of silk worms, the reeling and weaving of domesticated and wild silks, wool spinning and weaving and the fibre industries.* Practical experiments under commercial conditions should be conducted in a demonstration factory attached, with a view to the discovery of methods suitable to local conditions. Besides demonstrating the working of all improved appliances which have been designed and new methods of work, the factory should serve as a place for providing practical instruction for stu-

dents undergoing training in advanced branches of the textile trade in the institute.

II. *The establishment of provincial textile institutes to train a class of teachers, demonstrators, managers of hand-loom factories and leaders of the industry.* Commercial sections should be attached to these to provide practical training and to demonstrate the use of improved appliances for the production of indigenous patterns of textiles. The institutes should also train a class of *mistris* and conduct experiments for the special benefit of the province.

III. *The establishment of small demonstration stations for the development of indigenous industries peculiar to the provinces,* such as the production of domesticated and wild silks, shawl, carpet or blanket weaving, coir, hemp or mat manufacture, etc., by conducting experiments and by demonstrating the use of appliances employed in these industries.

IV. *The establishment of weaving schools in large weaving centres to train the sons of artisans who have completed their elementary school education.* Practical training in the use of all weaving appliances should receive most of the attention of the students, who, after a regular school course, should work for at least six months on the looms set apart for the purpose as regular weavers on wages at piece-work rates current in the locality. The object of such a course is to instil business habits into the students' minds to enable them to enter industrial life immediately after leaving the school.

V. *The provision of facilities for manual training in weaving in all elementary schools in localities where the weaving community forms the bulk of the population.*

VI. *The institution of peripatetic weaving parties to demonstrate the working of labour-saving appliances and to train weavers to use them in their own cottages.* To begin with, one party may be provided for an area having about 10,000 looms, with a *mistri* for every 2,000 looms. The area covered by each party may be further restricted as the demands for technical help increase.

VII. *The establishment of a provincial weavers' stores and textile workshop, with branches in the case of the larger provinces, for the manufacture of weaving appliances under expert supervision and their sale to the weavers in the villages, at the initial stage of the working of the department, through demonstration parties.* Such an institution is, necessary so that mistakes may be avoided and confidence created in the weavers. When the local carpenters are

trained and dealers in weavers' requisites come into existence, the Government may either close this section of the department or hand it over to a private agency. A good plan, perhaps, would be to conduct it through a federation of co-operative societies.

Trade organization

I. *The formation of village weavers' societies as credit societies to finance the weavers and to enable them to clear their prior debts, etc.*

II. *The institution of weavers' stores for financing trade and conducting business.* The stores would purchase raw materials direct from the spinners, standardize the patterns and deal wholesale, thus encouraging mass production. The relation of the weavers' stores and the village societies would be those of the contractor and his *mistri*, the former supplying the capital and undertaking the main responsibility and the latter supplying the labour, until he too earns or finds sufficient capital to enter into partnership and share in the entire profits. The ultimate aim of such an organization is the establishment of federations of village societies, each controlling its own affairs and enjoying the entire profits of the trade.

III. *The establishment of a provincial depôt to help the weavers' stores in the disposal of their products*, both in he province and outside, including foreign countries, by opening an industrial museum and by advertising. Such a depôt can also assist the stores in keeping them in touch with the markets outside, both for raw material and finished goods.

In addition to the suggestions made above, in order to secure enough raw material of good quality for the hand-loom weavers, the starting of spinning mills specializing in yarn for hand-looms should be encouraged.

Some attempts are being made in the direction of helping hand-loom weaving in India, either by demonstration parties or by weaving schools or weavers' societies, but these schemes generally lack comprehensiveness. The author has ventured here to state his views regarding the need for improvement of the hand-loom industry in India, as he believes that this industry will be a determining factor in the future economic advance of the country. He hopes that those who are interested in the well-being of the country will give the matter the consideration which its importance deserves.

K. S. RAO

MANGROVE SWAMPS OF THE SUNDERBANS FOREST DIVISION, A VALUABLE SOURCE OF TANSTUFFS*

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General occurrence of mangroves

Like similar regions in the tropics, the Sunderbans contain varieties of trees which are grouped together under the common name of mangroves. These trees flourish in the swamps at the mouths of big rivers in tropical countries. They grow in the alluvial soil and their roots and the lower part of their stems are often submerged in salt water from the sea. The entire coast of the Federated Malay States, [2, 3, 4] the coasts of the Pacific Islands, [5 to 9] *viz.*, Borneo, Sumatra, Java, the Philippines and Australia, the African [10, 11] and South American [12, 13, 14] coasts are all full of these mangrove swamps. With a view to exploit these resources for timber and tanstuffs, surveys have been made of the areas under mangrove in most of these countries, from which it appears that the world's supply of mangrove is yet almost inexhaustible and that most of the forests are still quite virgin.

The species found in the eastern tropics and the variations in their tannin contents

The species found in the various mangrove swamps of the world resemble one another. Among those met with in the eastern tropics the following seem to be very common:

Rhizophora mucronata.
,, *conjugata.*
Ceriops candolleana.
,, *roxburghiana.*
,, *tagal.*

* The numerical references in this article are to the bibliography on page 498 to 499.

Bruguiera gymnorrhiza.
„ *eriopetala.*
„ *parviflora.*

The predominating species in most of the Pacific Islands, as well as on the African and South American coasts, is reported to be *rhizophora mucronata; ceriops candolleana* and *bruguiera gymnorrhiza* come next, the other species occurring in much smaller quantities.

The tannin content of a species varies greatly in different regions. For instance, the bark of *rhizophora mucronata* is reported to have on the average—

30-40	per cent. tannin	in the Malay States.[2]
20·5	„ „	in Borneo[5]
27·6		in the Philippines.[5]
36·5		in German East Africa.[10]
30		in South America.[13]
35		in the Sunderbans[1]

Hence the investigation of the mangroves of one region is no criterion of what their economic value will be in other regions. A systematic survey of the mangroves of various regions is, therefore, necessary.

Pilgrim's investigation of the Sunderbans mangroves

Mr. J. A. Pilgrim was deputed by the Government of Bengal in June 1919 to survey the tanstuffs of the Sunderbans Forest Division. He confined his attention principally to the mangroves as they are the predominating trees in those forests

The main divisions of his work may be outlined thus:

(*a*) a general survey of the various species that occur in the Sunderbans,
(*b*) an estimate of the species that preponderate,
(*c*) collection of the various parts of trees with a view to ascertaining their tannin contents,
(*d*) analysis,
(*e*) deductions from the analyses regarding suitability for the manufacture of tannin extracts or for direct use in tanneries,
(*f*) small scale tanning tests with promising materials.

(*a*) *and* (*b*).—Mr. Pilgrim has reported on altogether 18 varieties, of which the following four are the commonest in the Sunderbans:

Sundri—Heritiera minor.
Goran—Ceriops roxburghiana.
Gengwa—Excœcaria agallocha.
Keora—Sonneratia apetala.

Out of these four he thinks that at least three, or parts of them, are likely to be useful. It is noteworthy that *rhizophora mucronata*, which is so abundant in all other mangrove swamps of the eastern tropics, is not quite so common in the Sunderbans.

(*c*) *Collection of tanstuffs.*—In this branch of his investigation Mr. Pilgrim has shown admirable industry and thoroughness. He left nothing to chance nor did he take anything for granted. He went to the Sunderbans himself with some of his staff and had the samples collected under his personal supervision. He took scrupulous care lest the samples should deteriorate in the interim between collection in the forest and analysis at the laboratory in Calcutta. The best method he found for preserving the materials in good condition was to crush and dry them in the sun soon after their collection from the trees. Most barks, fruits and brittle leaves could easily be brought to a fine state of subdivision by crushing. Brittle leaves were crushed by rubbing between the hands, while tough ones were torn into bits and dried. Tough fruits were thinly sliced and dried. Wood was sawn, and the sawdust collected from cuts at different portions, the average of the sap and heart woods being invariably taken wherever they were found to be different in nature. The immediate crushing and drying adopted by Mr. Pilgrim kept the materials free from fermentation by driving off the moisture, and, consequently, preserved the tannin undeteriorated. In crushing, iron was avoided as far as possible and drying was done in the sun. Artificial drying was adopted in only one or two cases when it was not possible to obtain the heat of the sun. F. A. Coombs and G. H. Russell state, however, that drying in direct sun-light darkens the colour [9] [15]. R. Williams in his paper on the economic possibilities of the mangrove swamps of the Philippines (*Journal of the American Leather Chemists Association*, 1911, p. 392) also says that exposure to air and light causes oxidation, resulting in loss of tannin and production of red colouring matter. Corroboration of these statements seems desirable.

Mr. Pilgrim also recommends his method of collection in bulk, and there can be no doubt that, if it be followed in practice, the quality of tanstuffs will be much improved. Not only will the tannin contents be higher, but the formation of the objectionable reds through fermentation and oxidation in many tanning materials will be much abated, resulting ultimately in a better coloured tannage. A case in point is afforded by the bark of *goran* (*ceriops roxburghiana*). *Goran* logs are imported into Calcutta from the Sunderbans with the bark on. Stripping is done in Calcutta. When the bark is on the felled logs its outer surface dries out; the interior and the surface next to the wood cannot dry, and, consequently, fermentation sets in, leading to the partial destruction and discoloration of the tannin. The *goran* bark, as obtained in the Calcutta bazar, analyses to 19-20 per cent. tannin and is of a dirty red colour, while the bark stripped and dried in the Sunderbans according to Mr. Pilgrim's method showed 36 per cent. tannin and was less red in colour. A striking illustration of badly preserved samples is given by the figures of analysis of some German East African mangroves.[16] Samples of the following species analysed at the Freiberg school showed much lower tannin content than well preserved samples analysed at Berlin. The former were collected and sent to Freiberg in a badly preserved condition :

	Percentage of tannin	
	Berlin (Busse)	Freiberg
Bruguiera gymnorrhiza	61·64	21·60
Ceriops candolleana	42·27	27·50
Xylocarpus granatum or *Xylocarpus obovatus* .	40·49	8·70
Rhizophora mucronata	47·99	21·30

Similarly, Blockey reports some analyses of Indian mangrove barks which were evidently sent to England from India and had deteriorated through bad preservation. Blockey's figures are given

side by side with those of Mr. Pilgrim obtained from the analyses of his carefully preserved samples. The figures speak for themselves:

	PERCENTAGE OF TANNIN	
	Blockey	Pilgrim
Bruguiera gymnorrhiza	9·7	31·55
Kandella rheedii	17·3	13·34
Rhizophora mucronata	4·5 6·1	35·0

From each species Mr. Pilgrim collected not only bark, fruit, leaf and wood but often took separate samples of the bark of the twigs, branches and the bole (sometimes the outer corky scale of mature barks was separately collected and analysed), of the outer husk and the inner kernel of the fruit, of the young and mature leaves, of the branch wood and the bole wood. Thus he collected and analysed altogether 80 samples from the different parts of the trees.

(*d*) *Analysis*.—The samples were analysed at the laboratory of the Calcutta Research Tannery. All the analyses were carried out under Mr. Pilgrim's personal supervision, as a matter of fact mostly by himself according to the official method of tannin analysis. The results have been calculated on the dry basis of the material. The amount of sodium chloride present in each sample was also determined, as it forms an important item from the point of view of extract manufacturers. No colorimetric determinations of the analytical extracts were made. Those would have been of some comparative value in judging the colour of the ultimate tannages.

(*e*) *Deductions from the analyses as to the suitability of the materials for the manufacture of tannin extracts or their direct use in tanning*.—There are few vegetable substances which are absolutely free from tannin, so the mere finding of a certain percentage of tannin in a vegetable product is not of much importance, either to the tanners or to the extract manufacturers. Besides tannin content, there are other factors which decide the suitability or otherwise of a particular material for direct use in tanning or for making extracts.

In the manufacture of tannin extracts one of the chief deciding factors in the selection of raw materials is the proportion of tannin to soluble non-tannin present in the material. It may be regarded as a general rule that, if the ratio of tannin to soluble non-tannin in a material be higher than unity, it is suitable for making extracts; if the ratio be lower than unity it is unsaleable. It is so because a commercial solid tannin extract containing less than 50 per cent. tannin (on a dry basis) is practically unsuitable, and a little consideration will make it clear that it is impossible to obtain such an extract from a material which yields more soluble non-tannin than tannin, *i.e.*, in which the ratio of tannin to non-tannin is less than unity. So this rule is to be clearly remembered when recommending any material for extract manufacture.

Another factor which is to be considered in the case of mangroves is their chloride content. Growing in salty swamps near the sea, not only all mangroves but all parts of the trees, *viz.*, fruits, leaves, barks and wood, have been found to contain chlorides, but their amounts have been found, curiously enough, to increase from the trunk to the top of the tree. While tannin is being extracted from the materials the chlorides will naturally pass into the tan-liquors and will show themselves in the concentrated extract. The presence of an undue amount of chloride is looked upon as an adulterant and is, therefore, objectionable. In the case of mangrove an allowance up to 3 per cent. chloride may be made, but to anything more than that, Mr. Pilgrim asserts, there will be serious objection.

These are the two main factors which Mr. Pilgrim has brought to bear upon his discussions regarding the suitability of the various materials which he has analysed for extract manufacture. By doing this he has given a practical turn to his whole report and has made it eminently useful to the prospective manufacturers of extracts from the Sunderbans mangroves. He was not satisfied with merely cataloguing the materials which he considered suitable in a dry table, but has taken great pains to calculate (1) the yield of the extract in popular commercial forms, (2) the expected percentages of tannin in the extracts and (3) the quantity of material required to run an extract plant of suitable commercial size (*viz.*, three tons daily capacity). It is to be expected that these handy figures will make a more direct appeal to busy matter-of-fact financiers than if they were left to be calculated from the figures of analyses. And, after all, the commercial exploitation of Mr. Pilgrim's pioneer work

must largely depend on financial considerations. The figures showing the yield of extract from selected materials are given in Table I appended to this article. A glance at them will show that, both in yield of extract and in percentage of tannin in the latter, the following three out of the 21 recommended stand out pre-eminent, *viz.*, the bole barks of (1) *gurjan* (*rhizophora mucronata*), (2) *goran* (*ceriops roxburghiana*) and (3) *kankra* (*bruguiera gymnorrhiza*). *Goran* is the commonest tree in the west Sunderbans, while *gurjan* and *kankra*, though not so common here as in mangrove swamps in other parts of the world, are by no means rare.

(*f*) *Small-scale tanning tests.*—Small pieces of delimed cow hides were tanned with some of the tanstuffs. The results are recorded in Table II. These small tanning tests are, of course, no absolute guide to what the results of bulk tannage with them will be, but they give some indication of the colour which they are likely to produce and of their weight-giving and penetrating properties.

Mr. Pilgrim's small tanning tests will require to be followed up by large-scale tanning, and he suggests that the Calcutta Research Tannery should undertake this work. Acting on his suggestion, it has been decided to collect bulk samples of the promising materials. Samples of the barks and leaves of *sundri* and *goran*, as well as *golpatta* leaves, have already been collected from the Sunderbans by the Research Chemist of the Calcutta Research Tannery. Ten bags of each kind have been obtained and tanning of both cow hides and goat skins with them is already well in hand at the Research Tannery. It is proposed to collect other samples later.

Summary of Mr. Pilgrim's investigations

Mr. Pilgrim's investigations may be summarized as follows:

I. The most abundant species found in the Sunderbans are (1) *sundri* (*heritiera minor*), (2) *goran* (*ceriops roxburghiana*), (3) *gengwa* (*excœcaria agallocha*) and (4) *keora* (*sonneratia apetala*).

II. Good extracts can be made from many, but *sundri* and *goran* being the most common and abundant, their exploitation for this purpose may be regarded as of immediate commercial interest.

III. *Pussur* (*carapa moluccensis*) is a valuable material, all parts of the tree, even the wood, giving good results;

but as it is not abundant, its reproduction is recommended to the forest authorities. Extract made from *pussur* wood is expected to produce a tannage similar to that of quebracho extract which is largely used by tanners in Europe and America.

IV. Large-scale tanning experiments with the indicated promising materials are recommended.

V. The importance of careful collection and preservation of tanstuffs for their ultimate tannin content and colour has been proved, and the adoption of Mr. Pilgrim's method of collection and preservation is urged on the trade.

Prospect of mangrove tannage

Dr. Paessler of the Freiburg (Germany) Tanning Institute, who has worked on the mangroves, regards them as providing the cheapest tan, considered per unit of tannin. One predominant characteristic of mangrove tannins is quick penetration into the pelts, which reduces the period of tannage to a considerable extent. Tannins belong to the class of substance known as colloids, which, as a rule, do not easily pass through animal membrane and penetrate very slowly into it. The quick penetration of the mangrove tannins consequently marks them out from all other tanstuffs, and probably it was on account of this property that a leather chemist, Lepetit, regarded the tannin of the mangrove as a sort of pseudotannin, which he thought was not permanently held by the leather fibre and could be washed out from the leather. Dr. Paessler has, however, shown Lepetit's view to be incorrect. Another Indian tanstuff is also remarkable in quick penetration, and this is the *turwad* (*cassia auriculata*) by which all the half-tan leathers for export are made in Madras and Bombay. Following Mr. Lepetit's argument, the *turwad* tannin may also be regarded as a pseudotannin. *Turwad* not only penetrates quickly, but its tan is very loosely fixed on the fibres so that it can be easily washed out. It is mainly this property which has made *turwad* tannage such a favourite with curriers in England. A short drumming with a little alkali removes the loosely fixed tannin and reduces the leather almost to pelt. In this pelt the currier gets a convenient raw material for the production of such leather as he desires by giving it a further suitable tannage. Sometimes these are re-tanned with gambier

and other vegetable tanstuffs, but more often they are chromed, producing the variety known as semi-chrome leathers.

Although most mangroves resemble *cassia auriculata* in power of quick penetration, the other properties of these two tanstuffs are as poles asunder. *Turwad*-tanned leather is nice and soft in feel and is almost cream coloured, while the mangroves impart to the leather a most objectionable, dirty-red colour and produce a leather which is harsh in feel and often brittle on the grain. These defects have hitherto prevented them from being universally used by the tanners of the world, and have caused the mangroves to be regarded as inferior tanstuffs. But, the abundance of their occurrence in the various parts of the globe, their richness in tannin, their remarkable power of penetration, the search after cheap tanning materials to stand in modern competition, and, above all, the growing dearth of the tanstuffs that have hitherto been favoured by tanners, have drawn the attention of the leather trade to the utilization of mangroves in tanning.

Mangrove tannage is quite common in Australia, the chief species used being *rhizophora mucronata* with some mixture of *bruguiera gymnorrhiza* and *ceriops candolleana*. From the quantities of bark imported into Germany from African coasts it may safely be assumed that mangrove tannage is in vogue in that country as well. It is being used also in England and America. In all these countries it is employed chiefly for the production of sole leather.

At the places of their origin mangrove barks have been long used by the native tanners. Thus, in the Pacific islands (Philippines, Borneo, etc.) in Brazil, Buenos Aires, in the African coastal regions and also in parts of India near the mangrove swamps they have been in use for the production of crude leather for generations.

The bark of *goran* (*ceriops roxburghiana*) has long been in direct use in several tanneries in Calcutta for the production of both buffalo sole and cow-hide upper leather. For very inferior grades of hides, meant to produce very cheap leathers, *goran* bark blended with about a quarter of its weight of myrabolan is employed. By this agency cow-hides are tanned through in about four weeks. The leathers turned out are coloured black and in shades of brown, rather heavily greased, and sold as very cheap upper leathers. Better grades of cow hides receive a mixed *goran*, *babul* and myrabolan tannage, but as *goran* has a bad reputation, the mixed

tanners do not like to admit that *goran* has been used in the tanning. They pass off the leather as pure *babul*-tanned.

Quite a large quantity of buffalo hide is also tanned with *goran* for the production of leather for *masaks* (water carriers) and for cheap soles. *Goran*-tanned sole leather is chiefly employed in the manufacture of munda shoes extensively worn by up-countrymen.

With a view to improve the colour of *goran* tannage a series of large-scale experiments was undertaken at the Calcutta Research Tannery. The results show that for sole leather, at any rate, quite a decent coloured stuff can be produced by blending *goran* with suitable proportions of *babul* and myrabolan. Sole leathers turned out at the Calcutta Research Tannery are selling at good prices at the auctions and are being freely purchased, even by European merchants.

Tanning experiments which are in progress at the Calcutta Research Tannery with another species of the Sunderban mangrove, *viz.*, the bark of *sundri* (*heritiera minor*), are also very promising.

There is little doubt that mangroves will gradually come to be used by the tanners of the world. A commercial exploitation of at least two varieties of Sunderban mangroves, *viz.*, the barks of *goran* (*ceriops roxburghiana*) and of *sundri* (*heritiera minor*), appears to be full of prospects. While they can quite well be used in normal times, during war they will prove invaluable as tanstuff resources of the empire. The British leather trade largely depends upon imported tanstuffs. Chestnut, quebracho, mimosa, valonia, sumach, gambier, in fact almost all tanstuffs used by the tanners of the United Kingdom are received from outside. The effect on the British leather trade of an enemy blockade cutting off these supplies can be more easily imagined than described. Leather, and good leather too, is a munition of war. The army must be shod and the cavalry needs accoutrements. The last war has taught some bitter lessons. If during the early part of the war America had not supplied England with sole leather it would have been difficult for the Northampton bootmakers to make deliveries of boots to the allied armies. India supplied practically the whole of the upper leathers for ammunition boots. She could have supplied soles as well, if her leather industry had been better organized. At any rate, she could have provided the British tanners with suitable tanning materials for turning out sole leather, had her tanstuff resources been previously explored.

Now that peace conditions are again prevailing, a serious attempt should be made to introduce the Sunderban mangroves into the leather trade. But, before that can be done, some important preliminary investigations are needed. For a new tanning material it is not enough to know its percentage of tannin content, not even the quality of leather it produces, but also whether it can be regularly delivered in quantity. Nothing is more annoying to a tanner than to find that a material upon the introduction of which he has spent much time and money cannot be obtained in more than a few hundredweights, whereas his requirements are, perhaps, to be gauged by several hundreds of tons a year. So, simultaneously with chemical and practical tanning investigations, the following points should be investigated in connection with the Sunderban mangroves :—

(1) What quantity of them is available ?
(2) What facilities exist for their collection and transport ?
(3) What is their cost delivered at a port, say, Calcutta ?

We miss definite information on these points in Mr. Pilgrim's report, and it is to be regretted that he had not sufficient time at his disposal to go into them. The questions are of vital practical interest and need answering by further investigation.

Mangrove extracts

The use of crude tanning materials is being fast supplanted by tannin extracts, as they offer many advantages, some of which may be enumerated as under:

(*i*) In extracts the tanner gets the tannin in a concentrated form. He needs only to dilute them with water to get the strength he wants. He is thus saved the trouble and expense of leaching.

(*ii*) The extract makes the use of strong liquors possible which quickens the process of tanning. This has given rise to the method of tanning with extracts in drums, by means of which leathers can be tanned in a week, whereas it formerly took six months to effect the same thing.

(*iii*) Easy transport and consequent saving of freight.

The adoption of Sunderban mangroves by the European leather trade would be much facilitated if they were turned into extracts before shipment. Mr. Pilgrim has shown that they are admirably

suitable for making extracts, containing generally, as they do, much more tannin in proportion to non-tannins.

Besides use in tanning, mangrove extracts are largely used for waterproofing fishing-nets and sails, and also to a large extent in dyeing as a substitute for cutch. Mr. Pilgrim has discovered two materials in the Sunderbans, extracts made from which he considers will be eminently suitable for dyeing, and he consequently recommends them for the manufacture of cutch. These are the waxy outer cortex barks of *pussur* (*carapa moluccensis*) and of *kankra* (*bruguiera gymnorrhiza*). As the removal of this dead outer cortex scale is not likely to damage the trees, the supply of the materials, especially of the former, is likely to be quite abundant.

Mixed mangrove extracts

Mangroves are also used in the manufacture of blended extracts. Containing, as they do, a high percentage of tannin, they increase the tannin content of the finished extract. J. Wladika says (Gerber, 1908, 34 No. 817-18, pp. 250-51, 265) that 20-25 per cent. of mangroves can be blended with the domestic (German and Austrian) tanning materials. The red colour produced can be masked by the addition of 5-10 per cent. myrabolan to the blend. It is also said that a secret factory process is known for decolorizing quebracho mangrove mixtures, enabling the manufacturer to dispense with myrabolans.

It is quite possible to make a useful tannin extract from suitable mixtures of *babul*, myrabolan and *goran*, the three standard tan-stuffs of Bengal. By varying the proportions of the components, different qualities of extracts might be made to suit the requirements of diffierent kinds of leather. Such mixed extracts are very likely to find favour in the domestic, as well as in the foreign, leather trade.

B. M. DAS

TABLE I

Pilgrim's figures showing the yield of extract, etc., from promising materials from the Sunderbans

No.	Names of materials	Percentage yield of extract with 15 per cent. moisture from air-dry raw materials with 10 per cent. moisture	Calculated theoretical maximum possible percentage of tannin in such extract	Percentage yield of crystals with 5 per cent. moisture from air-dry raw materials with 10 per cent. moisture	Calculated theoretical maximum possible percentage of tannin in such crystals	Tons of raw material (air-dry) required to run a plant of 3 tons daily capacity for crystals
1-2	*Heritiera minor—Sundri*					
	(*i*) Leaves	..	..	18·98	55·32	4,740
	(*ii*) Mature bark	..	..	14 53	61·37	6,200
3-5	*Carapa obovata—Dhundhul*					
	(*i*) Twig-bark	36·06	47·69	32 26	53·30	..
	(*ii*) Mature bark	41 77	55·42	37 37	61·94	2,410
	(*iii*) Buttress bark	43 01	64·15	38·48	71·70	..
6-10	*Carapa moluccensis—Pussur*					
	(*i*) Twig bark	25·32	51·01	22·65	57·02	..
	(*ii*) Mature bark (inner portion)	31·48	58 64	28·17	65·52	3,200
	(*iii*) Waxy outer scaly bark (cortex)	27 97	73·06	25·03	81·66	3,600
	(*iv*) Branch wood	..	..	10·85	61·98	8,300
	(*v*) Bole bark	..	..	11·83	67·01	7,610

11-12	*Rhizophora mucronata—Gurjan*					
	(i) Twig bark	..	..	..	48·00	..
	(ii) Bole bark	51·98	60·00	46·50	67·73	1,940
13-14	*Ceriops roxburghiana—Goran*					
	(i) Twig bark	33·62	51·70	30·09	57·78	3,000
	(ii) Bole bark	50·05	66·17	44·78	73·96	2,010
15	*Kandelia rheedii—Gora*					
	(i) Twig bark	..		23·03	59·3	..
16-18	*Bruguiera gymnorrhiza—Kankra*					
	(i) Twig bark	30·35	52·16	27·15	58·30	..
	(ii) Bole bark	50·42	56·32	45·11	62·94	2,000
	(iii) Waxy outer-scale for cortex bark . . .	20·27	61·64	18·13	68·89	..
19-20	*Lumnitzera racemosa—Kirpa*					
	(i) Twig bark	28·04	49·79	25·08	55·65	..
	(ii) Bole bark	31·95	53·77	28·59	60·09	.
21	*Excoecaria agallocha—Gengwa*					
	(i) Mature bark	.	..	18·29	50·00	

TABLE II

Results of Pilgrim's small tanning experiments with some promising tanstuffs

No.	Names of materials	Colour of tannage	Duration and nature of tannage	Yield of leather	Quality of leather
				per cent.	
1-2	***Heritiera minor*—Sundri**				
	(i) Leaves	Light cream	50 days, slow penetration	53	Soft, supple and tough with long fibre; without crack
	(ii) Mature bark	Reddish buff	43 days, slow penetration	55·5	Tough, supple, free from cracks, suitable for upper
3	***Carapa obovata*—Dhundhul** Twig bark and bole bark in equal quantities	Pinky buff	44+12 days,* rapid penetration	70·0	Very tough, not quite free from crack
4-5	***Carapa moluccensis*—Pussur**				
	(i) Mature bark	Reddish	5 days, rapid penetration	75·0	Extremely tough and practically impossible to tear
	(ii) Bole bark	Quebracho-like pink	50 days, penetration not so rapid as in previous	70·0	....
6	***Amoora cucullata*—Amoor**				
	Twig and mature bark in equal quantities	Pale pink	51 days	75·0	Strong and tough; suitable for uppers; some crack in the thickest part
7-8	***Rhizophora mucronata*—Gurjan**				
	(i) Fruit	Pale buff	Not very rapid	65·0	Free from crack
	(ii) Bole bark	Orange brown	Not rapid	75·0	Suitable for sole leathers
9-10	***Ceriops roxburghiana*—Goran**				
	(i) Leaves	Pale	24 days, fully penetrated but not thoroughly tanned for want of time	54·0	Supple, free from cracks
	(ii) Bark	Red	26 days, rapid penetration, not fully tanned for insufficient time	75·0	Leather cracks, but would have improved with another month in tan

11	*Kandelia rheedii—Goria*				
	Bark (twig and bole bark in equal quantities)	Pale terracotta	33 days, rapid penetration	69·0	Grain crinkled; some tendency to crack
12-14	*Bruguiera gymnorrhiza—Kankra*				
	(i) Leaves	Pale pink	12 days only, incompletely tanned for want of time	65·0	Supple leather without crack
	(ii) Bark	Ugly brick-red	17 days only, insufficient for complete tannage, rapid penetration	75·0	....
	(iii) Leaves and bark in equal proportion	Orange pink	12 days only	68·0	More pliable and less prone to crack than that produced by bark alone
15	*Lumnitzera racemosa—Kirpa*				
	Bark	Pale pinky	12 days only, insufficient for complete tannage	63·0	Supple and without crack but tore comparatively easily Stronger leather can be had on keeping longer
16	*Sonneratia acida—Ora*				
	Twig and mature bark in equal quantities	Dull buff	44 days	53·0	Soft, supple almost free from cracks
17-18	*Sonneratia apetala—Keora*				
	(i) Fruit	Pale buff with greenish tinge	58 days	53·0	Soft, supple, strong and quite free from cracks; more suitable for uppers
	(ii) Mature bark and twig bark in equal quantities	Pale pinky buff	52 days	60·0	Strong, with long fibre when torn, but the grain showed considerable crack
19	*Excoecaria agallocha—Gengwa*				
	Bark	Ugly, dull, dark-red	....	61·0	Showed some crack
20	*Nipa fruticans—Golpatta*				
	Leaflets	Almost white	17 days only, as no more time was available, penetration complete	52·0	Useful for preparation of light leathers

* The hide was kept for extra twelve days in order to get rid of the crack.

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INDUSTRIAL DISPUTES DURING THE THIRD QUARTER OF 1921

The following tables, I, II and III, give statistical information regarding industrial disputes which occurred during the third quarter of 1921. They have been prepared upon the same plan as those published in the previous numbers of the *Journal.*

They show a total of 88 disputes. Information has, however, been received of 7 other disputes (including the Assam-Bengal Railway strike) but the information is not yet sufficiently complete to allow of their inclusion in the tables.

Table IV gives detailed statistical information of the strikes in progress in Bengal in the second quarter of 1921. This information was received after the publication of the tables in the last number of the *Journal.*

TABLE I

Province	Number of disputes	Numbers involved	Days lost	Demands: Pay	Demands: Bonus	Demands: Personnel	Demands: Leave and hours	Demands: Others	Demands: Not known	Results: Successful	Results: Partially successful	Results: Unsuccessful	Results: Indefinite	Results: Not known	Results: In progress
Bengal	30	25,185	173,776	17	2	2	1	7	1	5	8	11	6	..	..
Bihar and Orissa	2	460	460	..	..	..	..	..	2	..	..	..	..	2	..
Bombay	40	56,439	422,976	10	1	6	2	21	..	8	1	29	..	..	2
Burma	7	561	2,046	3	..	4	..	..	..	1	1	3	..	1	1
Madras	5	12,500	526,946	2	..	1	1	1	..	1	1	1	..	..	2
Punjab	1	1,800	5,400	1	..	..	..	..	..	..	..	1	..	..	..
United Provinces	3	850	2,080	1	..	2	..	..	..	..	1	..	..	1	1
Total	88	97,525	1,133,684	34	3	15	4	29	3	15	12	45	6	4	6

TABLE II

Industry	Number of disputes	Numbers affected	Days lost	Demands: Pay	Demands: Bonus	Demands: Personnel	Demands: Leave and hours	Demands: Others	Demands: Not known	Results: Successful	Results: Partially successful	Results: Unsuccessful	Results: Indefinite	Results: Not known	Results: In progress
Cotton	33	53,616	710,569	6	1	3	1	21	1	4	2	22	2	..	3
Jute	4	15,400	130,300	..	..	1	1	2	..	..	..	4	..	..	..
Engineering works	9	1,800	3,480	3	..	1	2	3	..	2	2	3	2	..	..
Woollen	1	1,900	5,400	1	..	..	..	..	..	..	..	1	..	..	..
Railway (including workshop)	5	16,074	255,224	1	..	2	..	2	..	1	1	2	..	..	1
Tramway	2	2,530	5,120	2	..	..	..	..	..	..	..	1	..	1	..
Tea gardens	8	2,320	5,520	6	..	2	..	..	..	..	4	2	1	..	1
Municipal	2	640	1,960	2	..	..	..	..	..	2	..	..	..	..	..
Shipping	1	400	4,686	..	..	1	..	..	..	1	..	..	..	..	..
Printing	4	665	5,200	2	2	..	..	..	..	3	..	1	..	..	..
Rice mill	4	448	1,723	..	..	4	..	..	..	..	1	2	..	..	1
Saw mill	1	43	43	1	..	..	..	..	..	..	..	1	..	..	..
Miscellaneous	14	2,089	4,459	10	..	1	..	1	2	2	2	6	1	3	..
TOTAL	88	97,825	1,133,684	34	3	15	4	29	3	15	12	45	6	4	6

TABLE III

	July	August	September	Whole quarter
Disputes in progress at beginning	6	5	8	6
Fresh disputes begun	31	22	29	82
Disputes ended	32	19	31	82
Disputes in progress at end	5	8	6	6
Numbers affected	28,945	41,986	67,598	97,825
Days lost	237,282	402,001	494,401	1,133,684
Results of disputes ended—				
Successful	4	7	4	15
Partially successful	7	2	3	12
Unsuccessful	15	8	22	45
Indefinite	..	4	2	6
Not known	2	1	1	4

TABLE IV

Strikes in progress in Bengal in the second quarter of 1921

Trade Groups	April			May			June			Second Quarter of 1921		
	Number of disputes in progress	Number of employees involved	Aggregate duration in working days	Number of disputes in progress	Number of employees involved	Aggregate duration in working days	Number of disputes in progress	Number of employees involved	Aggregate duration in working days	Number of disputes in progress	Number of employees involved	Aggregate duration in working days
(1) Jute mills	6	38,000	123,500	2	5,500	9,000	..	..	..	8	43,500	132,500
(2) Cotton mills	1	4,600	24,400	1	4,600	4,600	..	..	..	1	4,600	29,000
(3) Railway workshops	3	9,100	104,300	2	8,800	272,800	..	..	..	3	9,100	377,100
(4) Light railways	..	..	..	..	..	..	2(f)	1,346	19,076	2	1,346	19,076
(5) Foundry and engineering works	..	..	..	..	..	..	2	94	778	2	94	778
(6) Tramways	..	..	..	1	200	..	..	..	..	1	200	..
(7) Cargo handling	..	..	..	..	..	..	1	800	..	1	800	..
(8) Docking works	..	..	..	1(e)	7,000	77,000	1	7,000	133,000	1	7,000	210,000
(9) Oil mills	1	600	9,000	1	600	13,600	..	..	..	1	600	22,600
(10) Bone mills	..	..	..	1	280	1,120	..	..	..	1	280	1,120
(11) Petroleum depôts	1	600	6,600	1	600	2,400	..	..	..	1	600	9,000
(12) Steamer Companies—crews and coolies, Calcutta	..	..	..	..	..	..	1	730	16,060	1	730	16,060
(13) Newspaper peons	..	..	..	1	40	120	..	..	..	1	40	120
(14) Municipal employees	1	250	1,000	..	..	..	..	..	..	1	250	1,000
(15) Stone cutters	..	..	..	1	150	150	..	..	..	1	150	150
(16) Masons	..	..	..	1	300	1,800	..	..	..	1	300	1,800
(17) Boatmen, Calcutta	..	..	..	..	..	..	1	1,150	3,450	1	1,150	3,450
(18) Caterer's servants	..	..	..	1	100	..	..	..	..	1	100	..
(19) River Police workshop, Naraingani	..	..	..	..	..	..	1	111	777	1	111	777
TOTAL	13(a)	53,150	268,800	14(b)	28,170	382,590	9(c)	11,231	173,141	30(d)	70,951	824,531

(a) Of these, 3 began in March: 2 in item (1); and 1 in item (3).
(b) Of these, 1 began in March, 4 began in April 1 in item (2); 1 in item (3); 1 in item (9); and 1 in item (11).
(c) Of these, the strike in item (8) began in May.
(d) Of the total of 30, 3 were carried over from the previous quarter, as shown in (a) and all but 3 (1 in item 4, 1 in item 5 and 1 in item 12) terminated during the quarter.
(e) A joint strike of 2 concerns managed by the same agents.
(f) Began as a joint strike of 3 lines; but one line resumed work independently.

SUMMARIES OF INDUSTRIAL INTELLIGENCE FOR THE QUARTER ENDING 30th SEPTEMBER 1921

Assam

Technical School for the Assam Valley.—A scheme for the establishment of a technical school for the Assam Valley, to be located at Jorhat, has been submitted to Government. It has been suggested that there should be two courses in the school, *viz.*, a foreman mechanic course and an artizan course, and that training in the school should be supplemented by apprenticeship in the railway workshops at Jorhat and Dibrugarh.

Tanstuffs.—The proposal to carry out experiments on Assam tanstuffs at the Calcutta Research Tannery has been abandoned, as the local Government have been unable to sanction the necessary expenditure.

Industrial loans.—A set of draft rules for the grant of industrial loans has been submitted to the local Government for approval.

K. L. BARUA,
Director of Industries.

Bengal

New industrial undertakings.—The following is a list of the industrial enterprises floated during the period under report :—

Name of the Company	Name of the Managing Agent, etc.	Authorized capital	Object
(1) The United Steel Corporation of Asia	Managing Agents, Bird & Co., Calcutta	Twenty crores of rupees	To carry on the trade or business of iron masters, steel makers, steel converters, coke manufacturers, etc.
(2) The Plassey Silk Factory, Limited	Managing Director, Mr. N.L. Bose, 72, Canning Street, Calcutta	Five lakhs of rupees	To carry on the business of manufacturing silk, cotton and woollen yarn and hosiery goods, etc.
(3) Assorted Cotton and Metal Products, Limited	Managing Agents, Industrial Improvement Co., 4 Gopal Banerjee Street, Bhowanipore, Calcutta	Five lakhs of rupees	To carry on all or any of the business of manufacturing cotton and metal products in India

Name of the Company	Name of the Managing Agent, etc.	Authorized capital	Object
(4) Kishoreganj Match Factory	Managing Agents, Chakraborty & Co., Kishoreganj, Mymensingh	Twenty thousand rupees	To open a factory for the manufacture of matches
(5) National Development, Ltd.	Managing Agents, The Commercial Medium, 55, Ezra Street, Calcutta	Five lakhs of rupees	To co-ordinate and expand existing industrial and agricultural enterprises and to invest in and promote new industries
(6) P. G. S. Works, Ltd.	Managing Agents, Nalinee Gupta &Co., Belgatchia, Calcutta	One lakh of rupees	To manufacture and deal in scientific apparatus of all sorts, laboratory requisites and chemicals
(7) The Dewangunj Sugar cane Mills	Director, Mahammad Abdul Hossain, Prodyotnagar, Dewangunj, Mymenshingh	One lakh of rupees	To purchase or to erect sugar cane mills and to carry on a profitable business by letting them out on hire
(8) Bengal Match Factory and Saw Mills	Managing Agents, Central Commercial Agency, 285-10, Bowbazar Street, Calcutta	Five lakhs of rupees	To start a match factory, saw mill, motor transport and engineering works, etc.
(9) The National Weaving, Ltd.	Managing Agents, Choudhury Mazumdar & Co., Kishoregunj, Mymensingh	One lakh fifty thousand rupees	To establish a weaving factory and weave cloths of any description, etc.
(10) East India Lac Company	1 Garstin's Place, Calcutta	Two lakhs of rupees	To carry on the manufacture, purchase or sale of shellac, lac, stick lac, etc
(11) The Rajshahi Sugar Farm, Ltd	Managing Agents, Sanyal Banerji & Co., 25, Strand Road, Calcutta	Two lakhs of rupees	To manufacture sugar, molasses, gur and to cultivate sugar cane, etc
(12) The Murarka Paint and Varnish Works	130, Cotton Street, Calcutta	Five lakhs of rupees	To carry on the business of extracting, purifying, manufacturing and dealing in vegetable and other oils of all kinds, paints, varnishes, etc. This is a private Company.

A new iron and steel factory.—The Kirtyanand Iron and Steel Works Ltd., Rupnarainpur, Burdwan, an Indian enterprise which was floated in February last with an authorized capital of Rs. 150 lakhs with the object of producing and manufacturing high class steel castings, etc., have made considerable progress. The construction of factory, office, godown and quarters for the European and Indian officers has been completed and the major portion of the machinery and plant has been installed. The actual manufacturing work, it is understood, will be commenced shortly.

The factory is situated on forty bighas of land. To complete its lay-out satisfactorily and for the construction of stores and future

extensions a further area of 25 bighas of land is required. The Managing Agents, Messrs. Pandit & Co., Calcutta, having failed to secure this land by private sale approached this Department for help under the Land Acquisition Act, but as the local Government were reluctant to entertain any application for the acquisition of land for industrial purposes till the Act is amended, the help sought could not be given. The difficulty has since been overcome. Two officers of this Department acted as arbitrators and have been successful in effecting an amicable settlement between the Managing Agents and the holders of the lands in question by persuading the Agents to offer to the tenants certain other lands in exchange for the lands required by the Company.

A new mechanical workshop. Messrs. P. N. Dutt & Co., Calcutta, well known manufacturers of buckets, have organized a mechanical workshop, run by electric power, for the manufacture of ordinary engineering tools and machines, such as drilling machines, lathes, etc. The Company is considering a scheme for the erection of a larger factory in the neighbourhood of Calcutta where land has already been secured. The arrangement and equipment of the present workshop and the quality of the products turned out appear to be quite satisfactory and the concern seems to be under efficient management and supervision.

Hand-woven clothing materials.—Chatra Cottage Industrial Works, Serampur, are manufacturing *dhotis*, *saris*, cotton canvas, paulins, bandage and *pagri* cloth, etc., in large quantities, all woven on handlooms. The scope and organization of the industry under the firm's control are capable of meeting reasonably large orders in a satisfactory manner. Their products have been recommended to the Director General of Posts and Telegraphs with a view to his calling for tenders from the firm.

Vegetable shoe.—The Indian Jute Shoe Co., Manufacturing Agents. Messrs. McLeod & Co., Calcutta, have asked for assistance in securing a larger market for their rope-soled canvas boots and shoes. Four thousand eight hundred dozen pairs of boots and shoes are the present monthly output of the firm, but they are capable of increasing the outturn according to demand. The *bonâ fides* of the firm are considered to be satisfactory.

Cardboard boxes.—Cardboard boxes of excellent quality and of various designs, both collapsible and otherwise, are being manufac-

tured by the Packing Materials Co. at their factory in Upper Circular Road, Calcutta. An officer of this Department visited the factory and investigated its processes and management. It is worked by Indian labour and is capable of sound development. The factory, although a newly started one, has already carried out numerous Government orders and is manufacturing boxes at the rate of something like 60,000 a month.

Paste board, cardboard, etc.—Paste board, cardboard and pulp board are being successfully manufactured by the Bengal Paste Board and Paper Mills Ltd., at their factory at No. 42 Tangra Road, Calcutta.

Manilla and coir ropes.—Manilla and coir ropes of various descriptions are being manufactured by the Howrah Rope Works Ltd. Their products have been recommended to the various consuming departments of Government and to railways.

Bobbins and shuttles.—Messrs. Abdul Gani & Co., Serampore, are now manufacturing bobbins and shuttles with *haldu, ghoranim* and book wood which are available in Bengal forests.

Hurricane chimneys.—Hurricane chimneys are being manufactured by the Bengal Glass Works, Dum-Dum (24-Parganas). The daily output varies from 3,000 to 4,000 chimneys.

Rice bowls.—Babu Jogendra Nath Chatterji, of North Bantra, Howrah, manufactures rice bowls of various types. The present output of the foundry is 2,000 bowls daily.

Automatic hand-loom.—Automatic hand-looms are being manufactured by Messrs. B. D. Bery & Co., of 43 Ripon Street, Calcutta, on a commercial scale under the instruction and guidance of the Principal, Serampore Weaving Institute. The machine has been reported to be working satisfactorily. The looms have now been made of metal instead of wood, and the price, as a result, has been raised from Rs. 250 to Rs. 325.

Paper pulp from paddy straw.—Messrs. A. Bonner & Co., Calcutta, have, at the request of this Department, agreed to undertake an experiment with paddy straw for the manufacture of paper pulp. One maund of straw has been supplied to the firm.

Paper pulp from ekra *grass.*—Seven seers of *ekra* grass have been made over to a firm who are experimenting on the manufacture of paper pulp from this grass.

Paper pulp from betelnut shell.—Paper pulp, it is understood, has been made by the Chemical Assistant to the Fibre Expert to the

Government of Bengal from betelnut shells. The details of the manufacturing processes have been asked for.

British Empire Exhibition.—It is proposed to exhibit at the British Empire Exhibition to be held in London in 1923 or 1924 leathers tanned at the Calcutta Research Tannery with the tanstuffs obtainable in the Sunderbans forest. As different varieties of tanstuffs will be used and as hides will be treated by batches, much time will be required to complete the whole series. Proposals have, therefore, been submitted to the local Government for the deputation of the Research Chemist and the necessary staff for the collection of tanning materials from November next.

Coal wagon difficulty. On the recommendation of this office, the Coal Transportation Officer arranged for the supply of the recommended number of wagons to thirteen firms and the cases of four firms were under consideration during the period under report.

Advisory Board of Industries.—Three meetings of the Board were held during the period under report. The more important questions discussed were as noted below.

(1) Possibility of establishing a pioneer tannery at Dacca.
(2) Suitable industries for jail convicts.
(3) Stores Purchase organization and rules.
(4) Desirability of not licensing any more factories in the central area of Calcutta.
(5) Participation of Bengal in the British Industries Fair, 1922.
(6) Establishment of a demonstration dairy in the neighbourhood of Calcutta.
(7) Reconstruction of the Controlling Body of the Calcutta Research Tannery.
(8) Establishment of a demonstration silk factory and a silk weaving school at Berhampore.
(9) Present position of the ship-building industry in Bengal.
(10) Establishment of a Junior Technical School at Hetampur, Birbhum.

New projects of the Department.—Schemes, with estimates of cost, for the following projects have been submitted to Government during the period under report:

A demonstration dairy in the neighbourhood of Calcutta.

A demonstration silk factory and a silk weaving school at Berhampore.

A Junior Technical School at Hetampur, Birbhum.

Training of Indians as apprentices in workshops and factories.—In 1919 a committee was appointed by the Bengal Government to co-ordinate a scheme for apprentice training in the Eastern Bengal Railway workshops at Kanchrapara with the Mechanical and Engineering classes of the Bengal Engineering College. This report contained various recommendations, and as a result of these recommendations the following action has been taken:

A Board of Control for Apprenticeship Training in Bengal was appointed by Government in June 1921 and has already held its first meeting. The Board is already preparing proposals for an apprentices' admission examination, applicable to all workshops in Bengal which care to take advantage of it as a help in the selection of their apprentices. It is hoped that the first examination may be held within the next few months. The Board is also already dealing with the revision of the courses in mechanical and electrical engineering at the Bengal Engineering College.

The following arrangements have been made in connection with the introduction of a revised scheme of training at the Kanchrapara workshops of the Eastern Bengal Railway:

(a) A hostel for the accommodation of 50 resident Indian apprentices has been built at the cost of Government and is almost ready for occupation.

(b) A residence for an Indian assistant master has been built at the cost of Government and is nearly completed.

(c) An offer has been made by Government to purchase for use as the technical institute for the railway apprentices the present office building at Kanchrapara, but this building cannot be handed over until a new office building has been erected by the railway authorities. In the meantime the classes are being held in other rooms.

(d) The Bengal Government are considering a proposal which has been submitted by the Director of Industries for the appointment of an assistant master for the apprentices on a pay of Rs. 350 to 500. The instruction at Kanchrapara is at present being carried on by a part-time teacher, and if the proposed assistant master is appointed an immediate improvement can be made in the teaching of the apprentices.

It is intended to provide further teaching staff subsequently.

Towards the end of 1919 a committee was appointed by the Bengal Government to advise on the establishment of a technical school in Calcutta, the primary function of which will be to provide part-time technical classes for apprentices employed in the various workshops of the district. As a result of the recommendations contained in the report of this committee the following action has been taken:

(*a*) A piece of land about six bighas in area in a central site in Calcutta has been purchased at a cost of about eight lakhs of rupees as the site for the erection of a school building. The acquisition of the land is almost complete and the ground is in the process of being cleared.

(*b*) Government have sanctioned in the budget for 1921-22 an allotment of Rs. 1,25,000 towards the erection of the ground floor of the school building, which will eventually consist of three floors. It is intended to start building as soon as the land has been definitely acquired and the ground cleared. The building will be so arranged that the ground floor can be used as a school pending the completion of the upper two floors. Each floor will provide accommodation for an actual attendance of about 300 apprentices. The site is large enough to admit of additional buildings when required.

(*c*) In June 1921 Government appointed a Governing Body for the Calcutta Technical School.

In the meantime part-time training for between 200 and 300 apprentices, both European and Indian, is provided in the Calcutta Evening Technical School, which receives a yearly grant from Government. Government allow the free use of rooms in the School of Art for these classes.

D. B. Meek,

Director of Industries

Bihar and Orissa

Coal supply.—During the last quarter, coal supply has been somewhat better, but there is every prospect of further acute difficulties during the coming cold weather, when there promises to be an actual shortage of coal as opposed to a shortage of transport.

Talcher coalfield.—One of the most interesting developments in Bihar and Orissa at present is the opening up of the Talcher coalfield. The outcrops in this field had long ago been examined by the Geological Survey and pronounced valueless. Recently Messrs. Villiers, Ld. have been conducting borings to lower strata and have located some 30 or 40 million tons of first class steam coal at moderate depths. This discovery, which brings a large supply of good coal some two or three hundred miles nearer, is of the greatest importance to Southern India, while the opening up of the new field should not only bring prosperity to Orissa, but, by tapping a new source of labour and relieving the congested lines round Jharia and Raniganj, help materially to solve the coal supply problem. The Railway Board have already sanctioned the survey of a line approximately 65 miles long from Kapilas Road Station, just north of Cuttack, to the Talcher coalfield, and this will be undertaken during the present cold weather.

New companies at Jamshedpur.—Mention is often made in the public press of the so-called subsidiary companies at Jamshedpur. Information regarding their actual position will, therefore, probably be welcome. Only two companies at present are actually at work—the Calcutta Monifieth Ld. and the Hume Pipe and Construction Co. The former enterprise has been carried through under the auspices of James F. Low & Co., Ld. of the Monifieth Foundry, Monifieth, Scotland, and will make machinery for the jute trade. Drawing frames are already being turned out quite equal to those produced in the United Kingdom and other types of machinery will be made in due course. The company also undertakes light castings of all kinds and can both cut and cast gears. The Hume Pipe and Construction Company has one of its several factories at Jamshedpur. It was originally located there in order to undertake contracts for the water supply and sewerage schemes of Jamshedpur town. It is already producing pipes in large numbers which have been accepted as satisfactory by the Town Engineer and will now undertake contracts for other parts of India. In addition to these two, factories are being erected by the Tinplate Company of India, the Indian Steel Wire Products Ld., the Enamelled Iron Ware Ld. and the Enfield Cables Co., Ld. The Tinplate Co. of India is a large company with a capital of Rs. 3½ crores which will take steel from the Tata Iron & Steel Co. in the shape of bars, and after rolling them convert them into tin plates. Most

of the output of the company will be taken over by the Burmah Oil Co., which holds a large interest in the concern. Copperas will also be produced as a by-product from the pickling operations and the company should be in a position to sell it very cheaply. The Indian Steel Wire Products Ld. is a smaller enterprise which should be working in the early part of 1922. It is proposed in the first instance to manufacture iron wire and galvanized wire, but later on woven wire and all similar products will be produced. The company is also erecting a factory for the production of steel shelves for record rooms. Details regarding Enamelled Ironware Ld. and Enfield Cables Ld. are not available at present. Another company, called the Agricultural Implements Co., which, it is believed, will manufacture *kodalis*, ploughs, &c. is about to put up a factory, and it is understood that another company is likely to undertake the construction of wagons out of Messrs. Tata's steel plates.

B. A. Collins,
Director of Industries

Bombay

Staff.—Mr. G. H. Thiselton-Dyer, the Deputy Director of Industries, returned from leave in September. Sanction to the entertainment of his establishment is awaited. Mr. Thiselton-Dyer's principal work will be the giving of technical advice and assistance to minor industries and assistance to cottage industries. Mr. F. E. Bharucha, Assistant Director of Industries, Ahmedabad, has meantime proceeded on leave. Mr. D. M. Gangolli, who has been assisting Dr. A. N. Meldrum in chemical research at Ahmedabad and who directed the work of the demonstration casein factory from the beginning, resigned in July to take up an important and well-paid appointment in Rangoon. A third probationary Circle Officer has been appointed for training in the departmental workshops at Dapuri near Poona.

Assistant Director, Ahmedabad.—Owing to the slackness in industry, Mr. Bharucha spent a considerable portion of the last quarter at the head-quarters office in Bombay. He arranged for trials of a new type of silk twisting machine which was designed by Mr. Tom S. Dawson, ex-principal of the Victoria Jubilee Technical Institute, Bombay. He has also arranged for trials of a sizing machine of

which the use has hitherto been demonstrated at one of the weaving schools. The machine is unsuitable for the individual weaver, but it is believed that, with intelligent demonstration, it might be introduced with advantage in some of the small weaving factories of Gujarat. Mr. Bharucha has also begun preparations for participation in the British Industries Fair. A dyeing demonstrator has been appointed to work under him at Ahmedabad.

Chemical research.—A good deal of work has been done in attempting to improve the colour of the magnesium chloride manufactured at Kharaghoda, but so far without any positive results. In the last month or two, the price of German magnesium chloride has been considerably reduced, and it is probable that the real fight of the local industry for a market is only now beginning.

The prices of casein have also fallen and the local industry is at a standstill. Casein which sold in London for over £60 a ton in February, was as low as £32 in June. Coincident with this slump in the casein market in London, the price for separated milk at Anand rose from 2 annas to 15 annas per 100 lb. In these circumstances the local manufacture of casein no longer pays and its manufacture has temporarily ceased. A similar situation arose some years before the outbreak of war. Samples of casein made at the demonstration factory at Anand were sent to the Indian Trade Commissioner for valuation. The two firms consulted reported very favourably, and one stated that the sample was the best Indian casein the firm had yet seen and was as good as the average quality of Argentine lactic casein. Although the outlook for the industry is for the moment unfavourable, experimental and demonstration work is continued. An experimental drier, designed by Mr. Bharucha to enable operations to be conducted throughout the monsoon, was not successful, and a fresh design is under consideration.

Samples of casein glue sent for test to the Madras Pencil Factory were reported to dry too soon. Fresh samples according to a modified formula have now been sent for further trial.

Some work was done by Mr. Gangolli on the treatment of castor oil with a view to reducing acidity. Dr. Meldrum has made arrangements for continuing this investigation, which may possibly be useful in connection with the Indian requirements of castor oil for aero engines.

Publications.—During the quarter, a bulletin by Mr. A. F. Yuill, former Assistant Controller, Oils and Paints, under the Munitions Board, on the vegetable oil industry of the Bombay Presidency was published,. This bulletin contains a great deal of valuable commercial and technical information regarding the vegetable oil industry. The methods of treating the different kinds of seeds are fully described and the utility and value of the different types of oil pressing machinery carefully estimated. The book is well worth study by anyone connected with the industry. The price is Rs. 1-13, postage 4 annas, and copies may be had on application, accompanied by a remittance, from the Director of Industries, New Custom House, Bombay.

Pottery.—The Bombay Development Directorate are now considering the development of the area in which the proposed demonstration pottery will be located if the scheme is sanctioned. Meantime proposals have been submitted to Government for undertaking production on a semi-commercial scale in the School of Art of teapots and flooring tiles. This will not only give the students in the School of Art instruction of a practical character, but will enable the Department to test the local market for common crockery and flooring tiles. Experiments are also being arranged to ascertain whether waste mica, after crushing and powdering, cannot be utilized for the manufacture of heat-proof tiles.

Government workshops.—The apprenticeship scheme progresses somewhat slowly. Sanction of Government to the entertainment of a schoolmaster for the primary education of the apprentices is still awaited. It is hoped to conclude arrangements whereby suitable repetition work will be obtained which will simplify the arrangements for practical training in the workshops. The experimental work at the workshops is now in charge of the Deputy Director of Industries. At the time of writing, the manufacture of a steam distillation plant for the manufacture of *rosha* grass oil is receiving special attention.

Reparation dyes.—A revised price list for the first and second allocations of reparation non-alizarine dyes was published in June. Owing to the weakness of the dye market the prices in this list have recently been considerably reduced. A third allocation of dyes in common demand was also received during the quarter and a price list at corresponding rates is now in course of publication.

Advisory Committee.—Three meetings of the Advisory Committee were held during the quarter. At the first, a list of functions was discussed and submitted to Government for approval. It was subsequently approved. The other two meetings were concerned chiefly with a discussion of the report of the Stores Committee and the proposed new rules for the supply of articles for the public service.

Fisheries.—The trawler returned from her fifth voyage on the 4th July with over 20,000 lb. of fish. The sixth voyage yielded about 16,000 lb., but the seventh voyage was curtailed by bad weather and only 4,000 lb. were landed. The catch per hour's trawling during this voyage was 251 lb., the best up to date. The best catch per hour's absence from port was 171 lb. during the sixth voyage.

In the first half of August the weather was bad; on two trips no fishing was attempted and on two other trips considerable damage was done to the gear. Two trips at the end of the month yielded 15,000 lb. of fish. The catches per hour's trawling as well as per hour's absence from port were, however, below the results obtained in July.

The experience up to the present has been that trawling in the day time is more successful than at night. The prices obtained in the market are poor, chiefly because of the small demand for fish which are little known or against which there is a prejudice.

At the end of the monsoon, Mr. Walker was relieved of his work in connection with the steam trawler and returned to Karwar to recommence his demonstration of the manufacture of fish oil.

R. D. BELL,
Director of Industries

Burma

Staff.—No further staff has yet been added, but the proposals are still under the consideration of the Government of Burma. Until this further technical staff is appointed, the work of the Department must be more or less at a standstill.

Factory inspection.—The Director of Industries has been given administrative control over Factory Inspection with effect from the 1st October 1921.

Government Press.—Proposals for placing the Government Press in charge of the Department are also under consideration of the local Government.

Technical education.—Technical education has not formally come under the Department. The Committee for the reorganization of the Insein Engineering College sat during September and collected evidence, oral and written, of heads of engineering firms and others interested in technical education. Mr. Heaton, Principal of the Sibpur Engineering College, is serving on the Committee. He came over from Calcutta in August and, until the sittings of the Committee began, was engaged in visiting various local industrial concerns and was also consulted regarding a faculty of Civil Engineering in the University. The Committee's deliberations are expected to be complete by the end of October.

Industrial survey.—Except in the Irrawaddy division, where an officer is on special duty, a survey on regular lines has not yet been undertaken. Even the Irrawaddy division officer has had to be diverted to Maungmya for the conduct of the special enquiries in connection with the census into social, economic and industrial conditions.

Special enquiries.—The enquiries mentioned in the foregoing paragraph are being conducted at Mandalay by Mr. W. F. Grahame, I.C.S., and at Maungmya by Maung Ba Htin, B.A., of the Burma Civil Service, who has been doing the work of Circle Officer at Bassein since April last. Their enquiries are expected to last from four to five months. Mr. H. O. Reynolds, I.C.S., was engaged from July to the middle of September on an enquiry into the economic conditions of the small rice-milling industry in the Prome, Mandalay and Shwebo districts, and has written a report which is in the Press. An enquiry into the mining industry of the Province is shortly to be undertaken by Mr. G. de P. Cotter, D.Sc., F.G.S., Superintendent, Geological Survey of India, in collaboration with the Director of Industries.

Advisory Board of Industries.—Proposals for the creation of an Advisory Board of Industries are under the consideration of the local Government.

Industrial loans.—Rules for the grant of loans for assisting cottage and small industries, based on Appendix M to the Report of the Indian Industrial Commission (Mysore Rules), as modified for use in Bengal, have been prepared by the Director and have been

submitted to the Development Commissioner. Legislation will, however, be required if it is decided to collect arrears as arrears of land revenue.

Sales Depôt.—The existence of the Depôt is now well known to the art and craft workers of Burma. Wares from all over the Province are being received regularly and a good market is being found. The opening of the Depôt was noticed in the Trade Supplement to *The Times* (London) and enquiries have been received from the United Kingdom, United States of America and British Columbia from persons seeking to establish agencies for the sale of Burmese art-ware through the Depôt. In order to establish overseas connections, however, an export house in Burma is required and this does not yet exist. Export business is outside the scope of the Depôt, which is run on a cash basis, and there is a good opening for a firm wishing to establish an export business.

Museum.—The Phayre Provincial Museum has been taken over by the Department of Industries and the exhibits are being arranged by officers of various Government Departments. The local Government has recognized the need for a whole-time curator, and enquiries are being made in India for the services of a suitable candidate. Until the Museum building is completed, only a few specimens in each line will be exhibited and the remainder will be catalogued and kept packed. This does not apply to the geological collection, which will be available for reference by the public as received.

Patna Weaving Exhibition.—The Province is taking part in the All-India Hand-Weaving Exhibition to be held at Patna during the ensuing cold weather.

Employment Bureau.—Under the local Government's orders, steps are being taken for the maintenance by the Department of Industries of a register of candidates for industrial, commercial and other employment for the purpose of bringing employers and candidates in touch with one another. The bureau is to be experimental for one year and to be confined, to begin with, to college students and school boys. Employers of labour and heads of educational institutions are being circularized giving details of the working of the bureau, mode of application, registration, fees, etc.

Labour.—In comparison with the previous quarter, labour has been very quiet. Four strikes only were recorded; three in July (two in Rangoon rice mills and one in a Mandalay saw mill) and one strike in September in a Rangoon rice mill. The July

strikes, two of which ended in complete failure for the strikers, had no connection with any political movement; while the September strike, which originated in the introduction at the mill of labour-saving machinery and consequent reduction of staff, is believed to have some connection with political agitation.

The further strike in the Insein Workshops of the Burma Railways Company came to a conclusion when the last date for old hands to rejoin expired and the staff has since been recruited without reference to keeping open jobs for old hands who struck.

H. B. HOLME,
Director of Industries

Central Provinces and Berar

Advisory Board.—The first meeting of the Advisory Board of Industries has been held. There are nine members of the Provincial Legislative Council on the Board. The Board has recommended Government to include in the budget of the Department of Industries for 1922-23 provision for:

(1) the reorganization of boiler inspection,
(2) the reorganization of factory inspection on lines which will include the provision of a health service,
(3) an experimental and research laboratory for vegetable oils, vegetable fats, etc.,
(4) a hostel school of handicrafts at Itarsi,
(5) a hostel school of handicrafts at Raipur,
(6) a leather school at Nagpur.

Sale of sleys, etc.—During the first nine months of the year 2,000 fly-shuttle sleys have been sold to weavers. This is double the number sold during the whole of the previous year.

Coal.—Factory owners are anxious about the coal supply.

Local coal is so poor that it causes serious trouble and loss of efficiency and output. A representation has been made to the Coal Transportation Officer.

New cotton mill.—Good progress is being made with the construction of the large and important Model Mills at Nagpur. When these mills start work there will be an addition of about 8,000 persons to the industrial population of Nagpur and the problem of housing them must be faced.

Emporium for the sale of products of cottage industries.—This emporium, situated in the Museum, has only been open a few months. With the exception of textiles there are no cottage products in this Province which would meet the requirements of purchasers abroad. A start has, therefore, to be made from the very beginning and from a point much behind that which other Provinces reached long ago. The Emporium is meeting with a greater measure of success than could have been expected, and visitors to the Museum have purchased a considerable quantity of goods.

Continuation School.—A proposal has been submitted to Government recommending the organization of a school at Nagpur, to be worked on commercial lines, for the advanced training of passed pupils of schools of handicrafts with a view to the creation of a local supply of master carpenters and foremen.

H. R. CROSTHWAITE,
Director of Industries

Madras

Exhibitions.—At the Industrial Exhibition which was recently held at Bezwada, the dresser sizing machine designed by the Textile Expert was awarded a gold medal. The Kerala Soap Institute, Calicut, and the Industrial Laboratory, Coonoor, were awarded gold and silver medals for their respective exhibits of soaps and inks. A great deal of interest was evinced in the departmental exhibits, especially the dresser sizing machine and other improved weaving appliances exhibited by the Textile Branch of the Department.

Palmyra fibre.—Information has been received from the Fibre Expert to the Government of Bengal, who is at present in England, to the effect that a market could be found for a considerably increased quantity of Indian palmyra fibre, and enquiring whether the quantity available for export could be increased. Prior to the war the chief countries which took the palmyra fibre exported from the Madras Presidency were Germany and Belgium, but during the last three years export has been mainly to the United Kingdom. The District Assistant Directors have been requested to ascertain whether the quantity available for export from their respective divisions could be increased, and whether, in order to bring this about, it would be necessary to offer something more than the present market price.

Granite.—The application of a Madras firm for a lease of certain granite quarries in the North Arcot district, which was strongly supported by the Department, has now been granted. The development of the scheme proposed includes the installation of modern machinery and plant for quarrying, and, if the cost of production is thereby materially reduced, a greatly increased demand for granite for building purposes in Madras City should result.

Scholarships tenable at the Victoria Jubilee Technical Institute, Bombay.—In order to provide facilities for students of this Presidency to undergo technical training in some of the existing and well-established institutes in other parts of India, and pending the establishment and development of such institutions in this Province, Government in 1914 sanctioned the award annually of six scholarships of the value of Rs. 30 per mensem each tenable by natives of the Madras Presidency at the Victoria Jubilee Technical Institute, Bombay. Since the year 1916, when the number of scholarships was reduced to three, scholarships have been awarded for the study of textile manufacture, technical and applied chemistry and sanitary engineering and plumbing. These scholarships have never been popular, and in no year since the scheme was inaugurated have all the scholarships been taken up. There is little doubt that the real cause of their unpopularity is the value of the scholarships, as, in view of the increase in the cost of living at Bombay, the amount of Rs. 30 per mensem is no longer sufficient for maintenance and school fees. Proposals have accordingly been submitted to Government with a view to the value of the scholarships being increased to Rs. 60 per mensem, which is considered to be the minimum amount necessary to maintain a reasonable standard of living at Bombay.

Madras Trades School.—The Government Trades School, Madras, which started in 1916 with two classes and 40 students, has now 217 students on the rolls and provides instruction in mechanical engineering, electric wiring, plumbing, machine drawing and practical mathematics. Mechanical drawing is also taught in the vernacular to *maistries* of the wood carving, metal and building trades. The development of the school has been restricted owing to the fact that it has been conducted in rented buildings. A site has, however, been provided for the erection of permanent buildings, and plans and estimates have recently been submitted to Government for sanction. The cost of the new buildings is estimated at Rs. 2,80,000

and the electric installation will involve a further expenditure of about Rs. 28,000.

Manufacture of glue.—As a result of experiments in the manufacture of glue which were undertaken by this Department, arrangements were made last year for the transfer of a small experimental factory in Madras to Messrs. Beardsell and Co., with a view to manufacture on a commercial scale. The terms under which the factory should be transferred to and managed by the Company were still under discussion when Messrs. Beardsell and Co. asked to be relieved of its management and control with effect from the 31st August. Mr. Chinnaswamy Iyengar, who held a scholarship granted by the Madras Government for the study of applied chemistry at the Indian Institute of Science, has been appointed to the charge of the factory, which he held under Messrs. Beardsell, on a salary of Rs. 300 per mensem.

Industrial Institute, Coonoor.—The object of starting this Institute is to introduce an organized fruit preserving industry on the Nilgiris and at the same time to systematize and extend the existing fruit culture. The preliminary experiments were carried on in Sir Frederick Nicholson's residence and the plant was domestic in character. The Lady Manager, Miss Channing Pearce, proceeded to England to extend her knowledge of the subject and to arrange for the purchase and shipment of the necessary plant required for manufacture on a commercial scale. Miss Channing Pearce arrived at Madras on September 14th. The construction of the Institute building was commenced in May under the supervision of the Industrial Engineer, and it is hoped that it will be completed early next year when manufacture on a commercial scale will be started.

Industrial Laboratory, Coonoor.—This laboratory was opened by Sir Frederick Nicholson at Coonoor. The subjects proposed for investigation were inks, adhesives and vinegar. Sir Frederick has been successful in producing inks, which, he claims, are equal in quality to the standard imported inks, and arrangements will shortly be made to place them on the market. The question of containers is, however, proving a difficult one, as it seems doubtful whether bottles of the requisite appearance and shape and of uniform size, quality and capacity can be obtained in India. Quotations are being obtained from English manufacturers for glass bottles, and at the same time experiments have been started with a view to develop-

ing the local manufacture of stoneware and earthenware jars suitable for inks, vinegar, jams and spices.

Kerala Soap Institute, Calicut.—It has not been possible, up to the present, to extend the instructional side of the factory owing to lack of accommodation and equipment. Estimates and plans have, however, now been completed and submitted to Government for a new factory at Calicut, and when the new buildings are completed it will be possible to take up in earnest the training of men in soap manufacture. The estimated cost of the new factory buildings is Rs. 94,350.

Coir industry.—It was stated in Volume I, Part 3 of the *Journal of Indian Industries and Labour* that the question of the development of the coir industry was under consideration. A conference attended by the Director, Deputy Director, Industrial Chemist, Weaving Expert and the Assistant Directors, Madura and Coimbatore divisions, was held during the month to consider on what lines further action in regard to the development of the coir industry in districts other than the West Coast should now be taken and the preliminary experiments, if any, which should be made. It was agreed that the first problem to be solved is the chemical one, and that steps should be taken to ascertain exactly what bacteriological processes take place in the Malabar back-waters, where the cocoanut husks are retted, and particularly to determine to what extent the bacteria which accelerate the disintegration of the fibre from its surrounding tissues are inherent in the husk of the cocoanut itself and to what extent present in the water. It was decided that Dr. Marsden should proceed to the West Coast, accompanied by the Assistant Director, Coimbatore division, and that they should investigate the conditions under which the retting process is carried on and obtain samples of water and also of husks before and after retting with a view to their subsequent bacteriological examination. The Industrial Chemist thereafter will endeavour to isolate the bacteria in the laboratory, and to evolve a process by which the bacteria might be artificially cultivated and utilized elsewhere than in Malabar.

The extracting, cleaning, spinning and weaving of coir yarn were also considered.

Coal.—Messrs. Best and Company have now been granted prospecting licenses over each of the three areas applied for in the Kistna and Godaveri districts. The firm have also applied for a prospecting

license over a further area of about nine square miles in the Polavaram division of the Godaveri District. Messrs. Best and Company propose to commence boring operations at an early date.

C. W. E. COTTON,
Director of Industries

United Provinces

Technological Institute.—The Council have voted funds, and six students have been selected for the Technological Institute which commenced work from the 15th September. Three will be trained as oil chemists and three as research chemists. The students are men who have passed the B.Sc. examination and have intimate connection with the business for which they are going to be trained. In the first year they will be taken through a course of mechanical engineering in the Technical School, Lucknow.

Future of technical education.—His Excellency the Governor attended a meeting of the Board of Industries on the 22nd June 1921, which was held at Naini Tal. Both the Hon'ble Ministers and Secretaries to Government were present. His Excellency's speech, which was published in important papers in June, conveyed a message of hope for the industrial regeneration of ancient Hindustan, and indicated the lines on which he, with the advice of the Industries Minister, would like to proceed. The scheme outlined the establishment of one technical school, at least, at the headquarters of every revenue division, the ultimate aim being the establishment of one school in each district.

Development Board.—His Excellency the Governor has recently constituted a Development Board with Mr. H. M. R. Hopkins, C.S.I., I.C.S., Senior Member, Board of Revenue, as Chairman, Mr. H. S. Crosthwaite, I.C.S., Secretary to Government, as Secretary and the following officers as members:

Mr. H. R. C. Hailey, C.I.E., C.B.E., I.C.S., President, Board of Agriculture,

Mr. A. W. Pim, C.I.E., I.C.S., President, Board of Communications,

Mr. G. Clarke, Director of Agriculture,

Mr. H. M. Willmott, Chief Engineer, Public Works Department,

Mr. A. W. E. Standley, Chief Engineer, Irrigation,

Mr. Makbul Hosain, C.I.E., Registrar, Co-operative Societies,
Mr. H. G. Billson, Chief Conservator of Forests, and
Mr. V. N. Mehta, I.C.S., Director of Industries, and President of the Board of Industries, United Provinces.

The principal idea behind the constitution of the Board is to tackle those problems which fall within the purview of more than one department. Such problems are liable to be neglected, especially when it is necessary to advance money for the successful establishment of any pioneer industry. The problems discussed by the Board at its first meeting were a proposal for a grant-in-aid to a sanitary dairy a survey of the raw products for the manufacture of essential oils and further experimentation by the Agricultural Department to increase the yield of rose flowers per acre and the yield of otto in each flower; the question of the wider advertisement by the Forest Department of its industrial activities; an enquiry into the drug-growing possibilities of the Province, and the necessity for looking into the fixed oil contents and their variations in respect of the various oilseeds of the Province. It was resolved that any proposition that required for its final solution the co-operation of more than one department should be referred by the department primarily concerned to the Development Board.

Glass Industries.—Mr. Varshani is trying to float a public company to establish up-to-date glass works in Bahjoi. The authorized capital of the company will be Rs. 8,00,000, and five lakhs are reported to have already been subscribed. Mr. Varshani's sons are in America undergoing training in the methods of manufacture of sheets and plate glass.

The Glass Works of the Western India Prospecting Syndicate, Shikohabad, have started with their first up-to-date furnace. The technical adviser states that they intended to add four or five furnaces more and were awaiting the receipt of fireclay and silica bricks ordered from the Calcutta Potteries.

The Firozabad manufacturers are turning out bangles of a more attractive style. Messrs. Framroz and Co. have been able to put mirror and *reshmi* bangles on the market. They have put down power machinery for polishing and turning their bangles. In spite of the fact that there were apprehensions of the Indian market being inundated by cheap Austrian stuff, Firozabad has been able to hold its own. The difficulties are chiefly due to scarcity of good

coal, delays in the receipt of coal wagons, and also in getting wagons for the despatch of the finished article.

Potteries.—The Industrial Chemist has been visiting Nizamabad, Khurja, Chunar, Gwalior and Delhi to find out the possibilities of improving indigenous potteries. The absence of known deposits of kaolin in the Province constitutes a considerable handicap. The potteries have ceased to turn out articles of utility and devote their energies to decorative articles. The glazing that is done at present is not satisfactory; for instance, the Chunar glazing cannot stand alkalis and Khurja glazing is merely a superficial coating of the earthenware which leaves the latter sufficiently porous for the absorption of moisture, with the result that the layer chips off. In the Brindaban Prem Maha Vidyalaya instruction is given for the manufacture of porcelain and glazed articles on more or less up-to-date lines. The kaolin is obtained from Ajmer. The Department intends to make experiments with a view to devising the best method of glazing the pottery which is now being turned out.

Cement.—The Principal of the Technological Institute has been making experiments with the manufacture of cement. Experiments have been made with specimens of calcareous marl obtained from the districts of Lucknow and Rae Bareli. Ordinary *kankar* with fat lime has been tackled for the manufacture of cement. The results appear to be promising. It is understood that a Lucknow engineer is floating a company to manufacture cement in the United Provinces.

Bone crushing.—A member of the Legislative Council from the Meerut district has been contemplating putting down a bone-crushing mill in connection with a demonstration farm which he is conducting in the district. He is anxious to know where the bone meal should be sent. Messrs. Allen Brothers are constructing a factory near Cawnpore for preparing bone meal. Most of the product will have to be exported, but it would be worth while to explore thoroughly the requirements of planters in India in respect of this manure.

Felt caps.—An up-country industrialist has started a felt cap manufacturing concern at Aligarh. The manager has been trained in the United Kingdom and has brought out up-to-date machinery for the preparation of the felt and its subsequent dyeing. He hopes to be able to put a felt cap on the market 30 per cent. cheaper than is being done at present. The difficulty at present consists in

getting good, cheap wool in sufficient quantities. He is being placed in communication with dealers of wool in Tanakpur and Bageshwar.

Hand-loom weaving.—During the Director's monsoon tour it was noticed that everywhere small factories were being put up to weave cotton cloth. The piece work system of payment has been adopted and yarn is mostly machine-made. A concern that confined itself to *charka*-spun yarn proved a failure and had to change its methods. Both in Allahabad and Shahjahanpur *kossa* silk is being woven on hand-looms on a considerable scale. No difficulty is found in getting either Italian or Japanese yarn. Most of the well-known drapers would buy their finished products at once. The difficulty at present is that there are no convenient hand-warping and sizing machines. The old process is both slow and clumsy.

The local Government have granted funds for participation in the All-India Hand-Weaving Exhibition at Patna and have offered two prizes of Rs. 100 each for the best multiple shuttle-box for the weft and for the best hand-worked sizing machine

Salt Supply Company.—A public company has been started at Cawnpore for the purpose of undertaking the supply of salt at cheap prices and of frustrating in this way the combination of Sambhar dealers who, according to them, have profiteered and pushed up prices.

Board of Industries.—At the meetings of the Board held on the 22nd June and the 5th September, a scheme for the training of foremen tanners in the Government Harness and Saddlery Factory was approved. It was recommended that the course should be one of five years: students should be given regular stipends, beginning with Rs. 35 and increasing with each year of their apprenticeship, and they should receive theoretical training during part of the time they are working in the factory.

It has also been decided to recommend to Government that a loan be given to a firm of Aligarh which desires to expand its enamel hollow-ware concern. Several other grants-in-aid to industrial schools were also sanctioned. They will be paid out of the funds put at the disposal of the Board of Industries.

Coal.—Complaints against shortage of coal at present are few. Difficulties are, of course, experienced owing to the non-supply of wagons at the desired time. Industrialists who have contracted with collieries in the Jharia field are asking for wagon facilities in that field. This can only be done if the present wagon facilities

are considerably extended. Collieries which are under agreements to supply coal at comparatively cheap rates on a system of forward contracts will be in a position to profit by the wagon shortage in these regions.

Labour situation.—Mr. Milner-White, I.C.S., has been inquiring into the present high prices of food-grains and at the same time arranging for the collection of family budgets and taking a census of wages. In reply to the demands presented by the Mazdur Sabha, the employees, after a resolution passed at a meeting, have stated that the Sabha does not represent the workmen and that they (the employers) were prepared to meet genuine representatives of the labourers at any conference for the purpose of settling their so-called grievances.

The following were the demands presented by the Mazdur Sabha:

1. An eight-hour day, and two annas per rupee increase in piece-workers' wages to make up for the reduction of time.
2. Revision of holidays for fairs and festivals, with special regard to the views and sentiments of the labourers.
3. Enhancement of wages in proportion to the dearth of necessaries, taking pre-war conditions as a basis.
4. Total abolition of fines.
5. Overtime and Sunday work to be taken as double time.
6. Respectable visitors, selected by the workers, to inspect the sanitary conditions and arrangements for workmen's comforts inside the mills.
7. Proper and adequate arrangements for medical treatment.
8. Adequate compensation and provision in cases of accidental injuries and death.
9. Abuse and corporal punishment to be strictly forbidden and compensation to be given to aggrieved workmen by the defaulters.
10. The employers to contribute collectively one lakh of rupees to the workers' Co-operative Credit Bank, without interest, for the liquidation of the debts of the workmen.
11. No reduction of the wages of old hands, without sufficient cause, on their re-employment.
12. No victimization for joining the Sabha.

13. Minimum living wages to be fixed for boys, girls, females and male workers.
14. All disputes to be settled by a board of arbitration.
15. Leave to be granted, when required, to the workmen.
16. Half the profits to be distributed as of right to the workmen as an annual bonus.
17. Old hands not to be replaced by new ones without sufficient cause.
18. No delicate person to be called upon to continue to work in a manner and under conditions that may injure his health, or cause physical injury.
19. Female labourers, when pregnant, to be granted two months' leave on full pay, about one month before and one month after confinement.
20. Proper provision for old age pensions.
21. The employers to recognize the Mazdur Sabha, Cawnpore, as the workmen's representative body.

V. N. MEHTA,
Director of Industries

MISCELLANEOUS NOTES

Briquetting Lignite and Indian Charcoal Experiments

We are indebted to the Forest Economist of the Forest Research Institute and College, Dehra Dun, for the following copy of interesting experiments in connection with briquetting lignite which were carried out on his behalf by the General Briquetting Company, New York, United States of America, who are also carrying out experiments with Indian charcoal.

TESTING LABORATORY

THE GENERAL BRIQUETTING COMPANY

New York

Job No. 30-B. Date March 1, 1920

Material carbonized lignite From Lignite Utilization Board of Canada, Montreal, Canada

Instructions received . Complete series of experiments on suitable binders and amount of mastication required

Classification of tests . Series I, II, III, etc.
Use for different kinds of binder, catalytic, or mixture of binders
Batch A, B, C, etc.
Use for different percentages of binder or catalytic

Series I. Hardwood tar
Series II. Coal tar pitch
Series III. Asphalt and pitch
Series IV. Sulphite liquor
Series V. Asphalt and coal tar pitch mixtures
Series VI. Asphalt and sulphite liquor mixtures

Batch I-A. . . . . 100 oz. lignite
12 oz. hardwood tar (M. P. 102, F.)

Heated lignite and added melted tar. Masticated one minute, masticator hot. Fair crawling condition. Reheated, and rolled immediately. Small proportion of briquettes obtained on first rolling, mixture appearing too hot. Rerolling gave better yield. Binder appears sufficient. Briquettes were scruffy.

Batch I-B. . . . 100 oz. lignite
11 oz. hardwood tar

Treated as in I-A., except 1½ minutes mastication. Fair yield on first roll Briquettes had a poor ring, and were more scruffy.

Batch I-C. . . . 100 oz. lignite
10 oz. hardwood tar

Proceeded as in I-A. Briquettes were poorer than both I-A. and I-B.

Batch I-D. . . . 100 oz. lignite
10 oz. hardwood tar
3 oz. water

Mixed tar in lignite hot and then added water. Masticated one minute hot. Reheated and rolled immediately. Briquettes obtained were only slightly better than I-C.

Batch I-E.
Part 1 . . . 9 oz. lignite
1 oz. anthracite dust
1·2 oz. hardwood tar

Mixed hot, masticating very little. Briquetted on hand press. Did not give any better briquettes than I-A.

Batch I-E.
Part 2 . . . 9 oz. lignite (coarse)
1 oz. lignite dust

Proceeded as in I-E, Part 1. Results were the same. The object of Test I-E, Parts 1 and 2, was to determine whether the anthracite, or lignite dust, would so fill up the voids of the coarse lignite, as to give less scruffiness.

Batch I-F. . . . 100 oz. lignite (Hoboken)
12 oz. hardwood tar

Materials hot, masticating for two minutes, masticator hot. Good crawling condition. Fairly good briquette. Scruffy surface. Comparable to I-A.

Batch I-G. . . . 100 oz. lignite (supposedly under 8 per cent. V. M.)
12 oz. hardwood tar.

NOTE.—Analysis 43 C. gave a result of 9·87 per cent. V. M. on this lignite.

Materials hot. Masticated 2½ minutes hot, and rolled immediately. Briquettes obtained were fairly good (about same as I-F.).

Batch I-H. . . . 100 oz. lignite (ground to go through 30 mesh)
12 oz. hardwood tar.

Materials hot. Very poor for briquetting. Hand press briquettes were N. G.

Series II.

Preliminary Run No. 1 .	100 pts. lignite	10 lb. lignite
	7 pts. C. T. P.	11·2 oz. C. T. P. (M. P. 155).

Mastication—

0 min.	Addition of hot tar and lignite to the masticator.
2½ "	Very poor.
4 "	Worse.
5 "	N. G.

Preliminary Run No. 2	100 pts. lignite 10 pts. C. T. P.	10 lb. lignite 1 lb. C. T. P.

Mastication—

0 min.	Material placed in masticator.
2 "	Fair appearance. No crawl. Not very dry. Poor briquette to hand pressure.
3 "	Getting dry. No crawl.
3½ "	Worse.
5 "	N. G.

Preliminary Run No. 3 .	100 pts. lignite 7 pts. C. T. P. 3 pts. water	10 lb. lignite 11·2 oz. C. T. P. 4·8 oz. water

Mastication—

2½ min.	Batch became very dry.
3½ "	Worse.
5 "	N. G.

Preliminary Run No. 3 on this series was repeated with the same result.

Preliminary Run No. 4	100 pts. lignite 10 pts. C. T. P. 5 pts. water	10 lb. lignite 1 lb. C. T. P. 8 oz. water

Mastication 2 min. . Added water and ground lignite fine. After addition of C. T. P. it looked better than Test No. 3. It proved, however, to be N. G.

Preliminary Run No. 5 .	100 pts. lignite 12 pts. C. T. P.	5 lb. lignite 9·6 oz. C. T. P.

Heated lignite to high temperature and added C. T. P. very hot. Mixed well. Appeared wet. Masticator hot.

Mastication—

1 min.	Batch crawling. No lumping. Better than others.
2 "	Good crawling. No lumps. Fair briquette to hand pressure.
3 "	Good crawling. Good briquette to hand pressure. Probably best condition.
4 "	Fair crawling. Poorer than 3 minutes. Getting dry.
5 "	Poor crawling. Drier.
6 "	Poor. Dry.

Preliminary Run No. 6 .	100 pts. lignite 7 pts. gas tar	100 oz. lignite .7 oz. gas tar

Mastication—

0 min.	Mixed well when hot. Lignite seems tar wet.	
1 „	No crawl.	No adhesive property.
2 „	„	No adhesive property.
5 „	„	No briquette to hand pressure.
7½ „	„	No briquette to hand pressure.
10 „	„	Falls apart after hand pressure. Material ground fine and not dry
12½ „	„	Very little adhesion to hand pressure.
15 „	„	Does not lump. A briquette on hand press at 4,800 lb. N. G. at 8,400 lb. very very poor.

Preliminary Run No. 7 . 100 oz. lignite
10 oz. gas tar

Mastication—

0 min.	Stuff mixes well when hot.	
2½ „	No crawl.	No briquette to hand pressure.
5 „	„	Little lumping.
7½ „	„	Little lumping. Appears better.
10 „	„	Better lumping.
12½ „	„	Still better lumping. Not good for briquette.
15 „	„	Briquette to hand pressure. Gave a poor briquette at 4,800 lb. on hand press. Also gave a poor briquette at 8,400 lb. on hand press.
17½ „	„	No improvement. Poor briquettes both at 4,800 and 8,400 lb. pressure.

Batch II-A. . . . 100 oz. lignite
13 oz. coal tar pitch (M. P. 180 F.)

Heated lignite and added melted C. T. P. Masticated 1½ minutes. Masticator warm. Material cooled too much in the masticator so reheated and rolled immediately. Briquettes broke apart, mostly in halves. Rerolled part of it. Those that were good were fairly hard. Binder sufficient.

Batch II-B. . . . 100 oz. lignite
12 oz. C. T. P.

Repeated II-A using 12 oz. C. T. P. and masticated one minute. Higher yield obtained than II-A. Slightly inferior.

Batch II-C. . . . . 100 oz. lignite
11 oz. C. T. P.

Repeated operations II-A. with 11 oz. C. T. P. Fairly high per cent. of briquettes returned. Surface not smooth. Very scruffy.

Batch II-D. . . . 100 oz. lignite
11 oz. C. T. P.
3 oz. water,

Materials hot. Masticated about one minute and then added water. Reheated until material was hot to touch. Rolled at once. Low yield of good briquettes. Rerolling fines resulted in increased yield.

Batch II-E. 1 . . 100 oz. lignite
11 oz. C. T. P.
5 oz. water

Proceeded as in II-D. Material at 150° F. when rolled. Fairly good briquette obtained.

Batch II-E. 2 . . Same proportion as II-E. 1

Material at about 110° F. when rolled. These briquettes were poorer and more scruffy than II-E. 1.

Batch II-F. . . 100 oz. lignite (Hoboken)
13 oz. C. T. P.

Masticated four and one-half minutes, materials and masticator hot. Moderate crawling condition. Material appeared good for rolling. Briquettes obtained were scruffy, but were stronger and seemed superior to briquettes from Batch II-A.

Batch II-G. . . 100 oz. lignite (supposedly under 8 per cent. V. M.)
13 oz. C. T. P.

Mixed well and masticated hot for three and one-half minutes. Rolled immediately. Briquettes obtained were about the same as II-F.

Batch II-H. . . 100 oz. lignite (ground to go through 30 M.)

Materials hot. Appeared much too dry for briquetting. Resulting briquettes on hand press N. G.

Batch II-I. . . 100 pts. lignite
13 pts. C. T. P.

Ground up the lignite in the masticator, added the coal tar pitch to the hot lignite and mixed by hand for 20 minutes, keeping the mixture heated on the gas range. Briquetted on the roll press. Briquettes slightly better than II-A, but do not compare with Canada briquettes alleged to have 13 parts C. T. P. to the 100 parts lignite.

Batch II-J. . . . 100 pts. lignite (ground fine)
16 pts. C. T. P.

Mixed hot. Masticated two minutes. Masticator hot. Briquetted on roll press with very good yield. Briquettes obtained were very good and are the best lignite briquettes yet obtained.

Series III—

Preliminary Run . . 100 pts. lignite
7 pts. hydrolene (M. P. 180)
10 lbs. lignite
11·2 oz. hydrolene

Condition —Hot to touch, not very moist.

Mastication—

$2\frac{1}{2}$ min. . . . Very good crawling condition. No briquette to hand pressure. Feels dry.

Mastication—*contd.*

5 min . . . . Feels and looks better. Good crawling. Poor briquette to hand pressure.

7½ „ . . . . Well ground. Looks good. Feels dry. Good crawling. Poor briquette to hand pressure.

10 „ . . . . Good crawling. Not so good as 7½ minutes. Better to hand pressure. Feels dry and unsuited to briquetting.

12½ „ . . . . Looks better and feels better. Still has dry feeling. Good crawling, good briquette to hand pressure. Best so far.

15 „ . . . . Very finely ground. Less crawling. Poorer briquette than 12½ minutes to hand pressure. Dry feel. Turning point passed.

17½ „ . . . . N. G.

Batch III-A. . . .	100 pts. lignite	10 lb. lignite
	7 pts. hydrolene	11·2 oz. hydrolene

Masticated ten minutes. Does not look good. Briquetted well, but briquettes are easily broken. Cannot stand pressure.

Batch III-B. . . .	100 pts. lignite	10 lb. lignite
	8 pts. hydrolene	12·8 oz. hydrolene

Masticated ten minutes. Feels too moist. Better looking. Good crawling. Rolls of press wet. Briquetted well. Soft, easily crushed. May be too wet.

Batch III-C. . . .	100 pts. lignite	10 lb. lignite
	8 pts. hydrolene	12·8 oz. hydrolene

Masticated five minutes. Good crawling. Material looks right, but feels dry and does not briquette well to hand pressure. Allowed to cool somewhat. Tried hand press, 4,000 lbs. Briquette was well formed but soft, light and easily crushed. Briquetted fairly well on roll press. Plenty of waste. Briquettes not so good. Poor ring, easily broken.

Batch III-D. . . .	100 pts. lignite	10 lb. lignite
	7 pts, hydrolene	11·2 oz. hydrolene
	2 pts. water	3·2 oz. water

Masticated f.. five minutes. Good crawl. Looks good. Not as dry as III-A. Forms under hand pressure. Hand press, 4,000 lbs. soft. Seems to briquette better when cooler. Fair briquettes obtained on roll press considerable waste, Poor ring. Better than III-C.

Batch III-E. . . .	100 pts. lignite	10 lb. lignite
	8 pts. hydrolene	12·8 oz. hydrolene
	3 pts. water	4·8 oz. water

Masticated five minutes. Very good crawling. Feels good. Stuck slightly to hand. Rolled warm. Briquetted well. Some waste. The briquettes obtained were easily crushed and did not appear very strong. They were quite light and had a dull ring.

Batch III-F. . . 100 pts. lignite — 10 lb. lignite
9 pts. hydrolene — 14·4 oz. hydrolene
2 pts. water — 3·2 oz. water

Masticated 7½ minutes. Excellent crawling condition. Feels good. Seems to be the best yet. Materials quite warm when rolled. Briquetted well, less waste than III-E. Stronger. Fair look, better ring and not so easily crushed.

Batch III-G. . . 100 pts. lignite — 10 lb. lignite
10 pts. hydrolene — 1 lb. hydrolene

Masticated for 7½ minutes. Crawls, but does not feel so good Seems to require more mastication. Looks as if there were too much binder. Rolled when warm to touch. Briquetted well, not much waste. Rather soft, weak, poor ring and easily broken.

Batch III-H. . . 100 pts. lignite — 10 lb. lignite
10 pts. hydrolene — 1 lb. hydrolene
2 pts. water — 3·2 oz. water

Masticated 7½ minutes. Good crawling. Makes a fine briquette to hand pressure. May have looked slightly better after six minutes mastication. Rolled—rather cool. Briquettes best yet; good, hard, very little waste. Did not break on being thrown to the ground. Good ring.

Batch III-I. . . 100 pts. lignite — 10 lb. lignite
8 pts. hydrolene — 12·8 oz. hydrolene
5 pts. water — 8 oz. water

Mastication 4½ minutes. Material very good. Briquetted well. Briquettes were hard and strong. Best yet.

Batch III-J. . . 100 pts. lignite (Hoboken) — 10 lb. lignite
8 pts. hydrolene — 12·8 oz. hydrolene
5 pts. water — 8 oz. water

Masticated for 4½ minutes. Material good; perhaps a little bit too sticky. Briquetted well with little waste. Good, strong briquettes obtained.

Batch III-K. . . 100 oz. lignite
8 oz. Imperial Oil Company's asphalt
5 oz. water

Masticated hot, 4½ minutes. Material appeared very good for briquetting. Good yield of briquettes. Were very good and had a fair ring. Binder sufficient. Surface good and only very slight scruffiness, if any. Stands fair drop without fracture.

Batch III-L. . . 100 oz. lignite
7 oz. Imperial Oil Company's asphalt
5 oz. water

Masticated hot, 4½ minutes. Briquettes obtained slightly inferior to III-K.

NOTE.—In adding binder to lignite in both III-K. and III-L., foaming took place.

Batch III-M. . . 100 oz. lignite (supposedly under 8 per cent. V. M.)
8 oz. hydrolene
5 oz. water

Mixed materials hot. Masticated 5 minutes. Rolled immediately. Briquettes were very good. Fair ring.

Batch III-N. . . 100 oz. lignite (ground to pass 30 mesh)
8 oz. hydrolene
5 oz. water

Heated lignite to about 200° F., added hydrolene while very hot. Lignite did not appear to mix readily with hydrolene. Resulting mixture was too dry. The addition of 5 oz. of water did not help. Further addition of water also seemed inadequate. Briquettes made on hand press crumbled. The addition of more binder seemed necessary.

Series IV—

Batch IV-A. . . 100 oz. lignite
10 oz. sulphite liquor (30°Be.)

Lignite heated hot to touch. Ground a little and S. L. added. Very little mastication. Poor. Dry. Rolled. No results. All passed through.

Batch IV-B. . . 100 oz. lignite
12 oz. S. L. (30°Be.)

Lignite heated, water added. Masticated a little and S. L. added. Little mastication. Batch wet, but not good for press. Very poor results on roll press. A few came out and crushed on grizzly.

Batch IV-C. . . 100 oz. lignite
15 oz. S. L. (30°Be.)

Proceeded as in IV-A. 4 minutes mastication. Rolled half came through in poor briquettes. Ran through press again—better than before—harder.

Batch IV-D. . . 100 oz. lignite
18 oz. S. L.

Masticated about 3 minutes. Rolled. Briquettes are hard and good.

Batch IV-E. . . 100 oz. lignite
16 oz. S. L.

Masticated about 4 minutes. Rolled. Briquettes are fairly good. About same as IV-D

Batch IV-F. . . 100 oz. lignite (Hoboken)
16 oz. S. L.

Masticated 2 minutes hot. Briquettes obtained were good. Are decidedly superior to IV-E.

Batch IV-G. 1 . . 100 oz. lignite (supposedly under 8 per cent. V. M.)
16 oz. S. L.

Masticated 2 minutes while warm. Added some water. Rolled immediately. Good briquettes obtained. Similar to IV-F.

Batch IV-G. 2 . . Same as IV-G. 1. Briquettes were baked in oven until temperature reached 530° F. and allowed to cool slowly. Briquettes obtained were quite brittle. Cracks formed on cooling.

Batch IV-H. 1 . . 100 oz. lignite (ground to go through 30 mesh)
16 oz. S. L.
9 oz. water

Thinned out the sulphite liquor with the water and then added it to the lignite. All constituents were kept cold. Masticated for two minutes. Masticator warm. Rolled. Briquettes appeared too wet, and were quite weak. Surface was very good. After standing several days, the briquettes acquired an excellent ring and became very hard.

Batch IV-H. 2 . . Briquettes from IV-H. 1

Baked in oven until temperature reached 530° F. Briquettes obtained were very good and had an excellent ring. Some showed cracking strains.

Series V—

Batch V-A. . . . 100 oz. lignite
5 oz. Imperial Oil Company's asphalt
5 oz. C. T. P.

Mixture on masticating appeared too dry. Masticated three minutes hot, reheated and rolled immediately. Very poor yield, probably due to dryness of mixture. Added some water and rerolled. Yield good, but briquettes obtained were poorer in quality than III-K.

Batch V-B. . . . 100 oz. lignite
7½ oz. Imperial Oil Company's asphalt
2 oz. C. T. P.

Added C. T. P. to lignite and then added asphalt. All materials hot. Masticated for three minutes. Added a little water. Reheated and rolled. Briquettes obtained were about the same as V-A.

Batch V-C. . . . 100 oz. lignite
7½ oz. Imperial Oil Company's asphalt
2½ oz. C. T. P.

All materials hot. Masticated one-half minute. Masticator hot. Fair crawling. Rolled immediately. Good yield of fairly good briquettes.

Series VI—

Batch VI-A. . . 100 oz. lignite
10 oz. S. L. (25 per cent. solids)
5 oz. hydrolene

Added hydrolene to lignite and mixed before addition of sulphite liquor. Masticated for three minutes. Reheated and rolled. Yield low. Briquettes seem to have insufficient binder.

Batch VI-B. . . 100 oz. lignite
10 oz. S. L. (25 per cent. solids)
5 oz. Imperial Oil Company's asphalt
Added sulphite liquor first and then asphalt. Masticated three minutes. Low yield. Practically same results as VI-A.

Batch VI-C. . . 100 oz. lignite
10 oz. S. L. (25 per cent. solids)
7 oz. hydrolene
Added hydrolene to lignite and then added sulphite liquor. All materials hot. Rolled. Good yield of good briquettes but not superior to III-D, as would be expected.

Batch VI-D. . . 100 oz. lignite
5 oz. S. L.
8 oz. hydrolene
Proceeded as in VI-C. Briquettes about the same in quality as VI-C. These briquettes were not any better than III-I.

Batch VI-E. . . 100 oz. lignite
8 oz. S. L. (30°Be. or 50 per cent. solids)
4 oz. hydrolene
Lignite ground fairly fine before the addition of any binder. It was then heated and the hydrolene and sulphite liquor were then added respectively. Masticated for four and one-half minutes and added some water because of the apparent dryness of the mixture. Rolled. Briquettes fair in appearance but seem o have insufficient binder.

Batch VI-F. . . 100 oz. lignite
4 oz. S. L. (30°Be.)
To the lignite, the hydrolene and then the sulphite liquor was added. A little water was added during the mastication. Masticated for five minutes. Rolled immediately. Fair looking briquettes obtained. Superior to briquettes from VI-E. Still seems to need more binder.

Batch VI-G. . . 100 oz. lignite
4 oz. S. L (30° Be.)
6 oz. Imperial Oil Company's asphalt
Proceeded as in VI-F. with practically the same results.

Santonin

Although it has long been recognized that India is peculiarly rich in drug-yielding materials yet their extraction and the local manufacture of drugs has up to the present made little headway. The reasons for this are many and are, in the main, identical with those which have retarded the manufacture of chemicals in general. In order to encourage the manufacture of drugs and to conduct the

necessary investigations connected therewith, the Government of India, acting on a recommendation of the Board of Scientific Advice, appointed some years ago a Drugs Manufacture Committee. The activities of this body are already commencing to bear fruit, and many drugs which were formerly imported are now being extracted from Indian-grown materials. It is the object of this short note to direct attention to a possible development of the drug industry which may become of considerable importance.

The drug santonin occurs in the young flower heads of *artemesia maritima* and finds an extensive use in medicine as a vermifuge. Prior to the war practically the whole of the world's supply came from Russian Turkestan where the flower heads were gathered and the drug extracted. It has not been possible to obtain any recent data as to the size of the industry, but the area under *artemesia maritima* must have been considerable, since in 1885 one factory dealt with 1,600 tons of the flower heads. At that date there were apparently at least two other factories, but no information is available as to their output. The industry was conducted in a somewhat primitive fashion; the plants were pulled by the nomad inhabitants of the district who stripped off the flower heads and used the remainder of the plant as fuel.

At this time the value of the santonin was estimated at £2 to £3 per kilo., but it could apparently be sold in Hamburg with a profit at 18 shillings a kilo. As a result of the unsettled conditions prevailing in Russian Turkestan no santonin is now being placed on the market, and the present price stands at the amazing figure of £50 per kilo. It is obvious, therefore, that some other source of supply of this valuable drug must be sought if adequate supplies are to be available once more. It has not proved possible to ascertain what the Indian demand was in pre-war years. The only figures obtainable show that the imports to Madras in 1913-14 were 340 lb., whilst the demands of the Medical Stores, if they could be met, would probably cost well over a lakh of rupees at the present price.

It has long been known that *artemesia maritima* occurs in Kashmir and Garhwal, but no systematic survey has been made of the quantity available, nor have experiments been made to determine whether the plant growing in these districts contains santonin, since it is well known that difference in habitat frequently alters the chemical constituents of a plant.

In 1919 Mr. Coventry, Conservator of Forests, Kashmir, sent several specimens of the flower heads of *artemesia maritima*, which had been collected in Kashmir, to the Forest Research Institute, Dehra Dun, with the request that they might be tested for their santonin content. The results of these preliminary tests were negative, except in one case where a trace of santonin was found. As it appeared possible that these negative results might have been due to the material having been collected at the wrong time, arrangements were made for samples to be collected weekly as soon as the shrub began to form leaves. As a result of this systematic examination of samples it was found that *artemesia maritima* grown in Kashmir contained an appreciable quantity of santonin. The following are a few of the results obtained:

1920	per cent.
July 9th	1·0
„ 15th	0·7
„ 25th	0·6
August 1st	0·7
„ 8th	0·6 (leaves alone, stems removed, 1·0 per cent.)
„ 22nd	0·6
October 2nd	0·5

These percentages, whilst considerably lower than those quoted for Russian material, where the santonin content is said to be between 1·8 and 2 per cent, are still considerable. The method of extraction adopted at Dehra Dun was made to approximate as closely as possible to that which would be adopted on the large scale and only the pure santonin was weighed. The results are, therefore, below the absolute santonin content, which is approximately one per cent.

It has been mentioned above that santonin is stated to be extracted from the young flower heads of *artemesia maritima*. A botanical examination of the specimens extracted at Dehra Dun has shown that the majority of the specimens consisted almost entirely of leaves, the flower heads being only markedly developed in the sample collected on October 22nd. Since santonin has not been noted previously as occurring in the leaves, it will be a matter of some interest to determine whether other parts of the plant contain santonin. Up to the present only the stems have been tested with negative results.

A welcome confirmation of the results obtained in India has been received in the publication of a paper by Professor Greenish and Miss Pearson (*Pharmaceutical Journal* 1921) who examined a sample of the leaves of *artemesia maritima* which had been sent to them by the India Stores Department. The specimen was definitely identified at Kew as consisting of the leaves of *artemesia maritima*, and it was estimated that it contained approximately 1 per cent. of santonin. From information supplied by Professor Greenish it appears probable that the specimen examined in London was a portion of the sample collected in Kashmir on July 25th, since part of this sample was sent to the Secretary of the Drugs Manufacture Committee. It will be observed that both the London and Dehra Dun estimations place the santonin content at approximately one per cent.

The writer is of opinion that *artemesia maritima* grown in Kashmir contains santonin in sufficient quantity for remunerative extraction, and from the information available there would appear to be sufficient supplies of the raw material. It now only remains for the laboratory results to be utilized on the large scale. The method of extraction is comparatively simple, and the only chemicals required are lime, hydrochloric acid and alcohol, all of which are readily obtainable in India. As the leaves are bulky, the factory should, if possible, be situated in Kashmir, but it is suggested that, as a preliminary, arrangements might be made for extraction at the Medical Stores in Lahore which is a fairly convenient centre for material derived from Kashmir. The next step, obviously, lies with the Drugs Manufacture Committee, and it is hoped that this short note may encourage them to take action. The time is opportune, since at present they have no competition to meet.

J. L. SIMONSEN

Electric fans on alternating current circuits

Although alternating current ceiling and desk fans, both single phase and three phase, have been on the market for some years, there is a distinct preference for continuous current fans. The latter are, on the average, decidedly more efficient, as well as more silent and simpler to regulate, while costing less than their rivals. The type of fan, however, has hitherto been fixed by the nature of the supply; and in the future, with hydro-electric power looming

large, there is likely to be a preponderance of alternating current supply schemes. At a recent conference the Punjab Government decided to encourage alternating current schemes in preference to continuous current, and it was noted that the difficulty over fans would probably be met by the use of small electrolytic rectifiers, which would convert so much power as was required in a house (for fans) from alternating to continuous current. It has now been ascertained that the Madras Electric Supply Corporation have already had this method under consideration for their outlying alternating current areas, and hope to introduce it shortly as the most efficient method of dealing with the fan load. From the central station point of view the very low power factor of alternating current fans is a great disadvantage.

J. W. Meares

REVIEWS AND NOTICES

PUBLICATIONS OF THE GEOLOGICAL SURVEY OF INDIA

(1) *Records, Geological Survey of India, Vol. LIII, Part 1* contains :

(*i*) *The General Report of the Geological Survey of India.* BY E. H. PASCOE.

(*ii*) *The Antimony Deposits of Thabyu, Amherst District, Burma.* BY A. M. HERON.

(ii) The author gives full particulars of the routes to the mine camp, Tinkale, which is situated close to the Siamese border. A brief description of the geology of the Amherst district follows, and the rocks are shown to consist of a series of slates, quartzitic sandstones, grits and impure limestones, similar to the Mergui series, forming two main ranges and a number of other hills. In the valleys between the ranges are extensive developments of the Moulmein limestone of Carboniferous age. A description of the ore deposits is given. The ore is stibnite, Sb_2S_3, largely converted into oxides at the surface, and occurs in a yellow or white calcareous chert. The ore bodies occur in a fine black fissile slate. A few figures showing the probable cost of mining and transport are given, and the results of two analyses show 61 per cent. of metallic antimony.

(2) *Note on Some Antimony Deposits of the Southern Shan States.* BY H. CECIL JONES. In this paper, detailing an investigation which was the result of the demand for antimony during the war, Mr. Jones describes five antimony deposits situated in the Southern Shan States, and one in Burma, just over the Shan States border. He states that none of them appear to be of much economic value. The positions and details of the several deposits are described. The mineral which occurs at all the deposits is the sulphide, stibnite, Sb_2S_3, usually much oxidized at the surface. The deposit situated at Naking in Mong Hsu State is the most important, and the results of a number of assays of the ore from the deposit are given. The ore averages about 35 per cent. of metallic antimony, and about 40 per cent. of silica.

(3) *The Geology and Mineral Resources of Eastern Persia.* By G. H. Tipper. The author gives a brief account of the geological structure of that strip of Persia lying between Ravar (about 80 miles north of Karman) and the coast, so far as this could be gathered from two rapid journeys to and from the coast and a rather more detailed investigation of the country round Karman itself. Although much of the route had already been traversed by geologists no less distinguished than the late Dr. W. T. Blanford and A. F. Stahl, yet Mr. Tipper has been able to make considerable additions to our knowledge of the various geological formations and to throw fresh light on their age. Of special importance are his exact descriptions, accompanied by microphotographs, of the igneous rocks of this area, which is characterized by at least six distinct epochs of vulcanicity between Palæozoic and recent times. The author's sketches and sections and the two geological maps render the stratigraphical descriptions perfectly clear.

He calls attention to the large spread of metamorphic rocks in Southern Persia in contact with Tertiary beds. While recognizing that they probably embrace rocks of more than one age, he finds that much more detailed work would be required to separate them. At the same time he inclines to an Archæan age for much of it, and disagrees with Blanford's suggestion that the crystalline limestones are really Hippuritic (Cretaceous) strata altered by igneous intrusions. Two small outcrops of limestone containing Carboniferous fossils were seen near Karman.

Conclusive proof is given of the existence of shallow water marine limestones of Upper Liassic age passing up into terrestrial deposits containing plant remains. The latter portion of this Jurassic series is widely distributed in northern Persia Afghanistan, Russian Turkestan and the Caucasus. The Hippuritic limestone rests unconformabl on these beds, although certain other strata of Cretaceous age found near Ravar and south of Karman may bridge the interval.

A thick series of ash beds, agglomerates and lavas, which compose the 15,000 feet ranges of Jamal Bariz and Kuh-i-Shah Sarawan, are described in some detail and are considered to be of Upper Cretaceous age.

A series of sandstones and shales, with both acid and basic intrusions and interbedded limestone bands containing Nummulites, which was observed by Blanford between Gwadar and Jalk, has

been identified by Tipper in other localities, for example, between Pozug and Ichan and in the Minab-Barinti gorge. These unconformably underlie the marine Mio-Pliocene series of the coast (Pilgrim's Upper Fars and Vredenburg's Upper Hinglaj). The latter series of beds agree with Blanford's description of them north of Chabbar. Mr. Tipper has found the same series near Minab.

Certain strongly folded conglomerates, gravels and shales, referred to in the Siwalik series, are exposed south of Karman and near Minab. Recent deposits, differing from the above only by the absence of dip, as well as raised beaches, are largely developed.

Finally, recent andesitic lava flows were seen on the northern slopes of the Gudar-i-Gishu, which are similar to those of the hardly yet extinct volcanoes of the Baluchistan frontier.

Of economic interest is Mr. Tipper's detailed account of various coal deposits which occur in the Upper Jurassic plant beds near Karman. He came to the conclusion that the seams are, unfortunately, of small extent and of little value. The abundance of copper ore scattered through the Jurassic shales and also in the Upper Cretaceous agglomerates is remarked upon. A determination of one specimen gave 6·2 per cent. of copper, but Mr. Tipper considers that the difficulties which would attend its working, owing to lack of fuel and inadequate transport facilities, render it unworthy of serious consideration at present. Small deposits of galena and asbestos are mentioned. Two paragraphs at the beginning and end of the paper deal with the progressive desiccation of Persia and its present water supply. It is suggested that artesian borings in the great plains of Persia might be as successful as they have proved to be in Baluchistan.

(4) *Bismuth in Tenasserim.* BY A. M. HERON. Small quantities of native bismuth have been found for some time in the eluvial deposits of both the Tavoy and Mergui districts of Burma. In the eluvial deposits of Tavoy the bismuth is always much oxidized, but on breaking the fragments an unoxidized kernel of the native metal may be found. Native bismuth has been found *in situ* in lode, occurring in the Kanbauk mine where it is associated with wolfram, cassiterite and the usual sulphides.

(5) *Memoirs, Geological Survey of India, Vol. XLVIII, Part 1.*

Geological Notes on Mesopotamia with special reference to Occurrences of Petroleum. BY E. H. PASCOE. This memoir consists of a

series of consecutive reports on areas which formed the author's itinerary during the cold season of 1918-19 in Mesopotamia. This itinerary consisted of a march from Tekrit northwards along the right bank of the Tigris as far as Mosul and a journey from Nineveh opposite Mosul to Table Mountain *viâ* Quwair, Altun Kupri, Kirkuk, Tuz Khurmatu and Kifri. The reports differ very little from the originals written from time to time in the field, and make no pretence to be more than corrected field-notes. The two principal series of rocks are the Fars of Dr. Pilgrim and a younger fluviatile deposit for which the author has proposed the term 'Kurd series' until it has been shown to what extent it coincides with Dr. Pilgrim's Bakhtiyari. The areas are dealt with *seriatim*, and a final report sums up the conclusions of scientific interest and the economic possibilities of this part of the country. The suggestion that emanations of hydrogen sulphide gas are due to the interaction of petroleum hydrocarbons and sulphates, such as gypsum, is of economic importance, as it makes every hydrogen sulphide emanation of scarcely inferior importance to an oil seepage. As a matter of fact, in most cases hydrogen sulphide is accompanied by bituminous earth. Qaiyarah and Quwair are considered to be prospective oil areas of first-class importance. Many other areas of less promise are thought to be worth testing, and a rough classification of them all according to their degree of promise is given. In the writer's opinion the Mesopotamian oil deposits will rival those of Persia and collectively outclass those of Burma. Besides an introduction, there are fifteen reports, which are illustrated by maps and several sections.

Some Hygienic Principles governing the erection of Factory Buildings. By R. Beattie, A.M.I.S.E., A.R.San.I. (London), Inspector of Factories, Transvaal and Orange Free States

The above is the title of an article which appeared in the *South African Journal of Industries* last July. It lays stress on the necessity of taking into consideration the needs of the workers when a factory is being planned. Many useful suggestions regarding light, ventilation, temperature and floors, are made which are applicable in India. Those relating to canteens, etc., need modification, but the contention that it is highly desirable that suitable places should be provided where workers can take their meals in comfort is equally true of this country also.

Report of the Department of Industries, Assam, 1920-21. 8 PAGES. (ASSAM SECRETARIAT PRINTING OFFICE. ANNAS 8.)

The Department of Industries in Assam was created at the end of the year 1918. As the Director of Industries remarks in his report for the year 1920-21, critics who are dissatisfied with the rate of progress as judged by large results are apt to overlook the difficulties which confront a new organization of this nature. The policy of the Department has at the outset been directed mainly to the development of cottage industries and the provision of technical and industrial training. The principal local industries to which the Department is devoting its attention are weaving and the manufacture of silk; but an interesting paragraph of the report deals with new ventures of considerable industrial importance. For the production of indigo Assam possesses very great natural advantages, and in the course of the year under review an important advance was made with the manufacture of cake indigo. The formation of a paper manufacturing company to utilize the local *savanah* grasses as its raw material is a venture the results of which will be awaited with great interest.

Report of the Director of Industries, Bihar and Orissa, 1920-21.

A welcome addition to the number of periodical publications dealing with Indian industrial development has been made recently in the shape of the first annual report on the working of the Department of Industries in Bihar and Orissa. The Department was formally constituted on the 7th April 1920, and in the course of the year added to its superior staff a Deputy Director and a part-time Chemical Adviser, while taking under its charge the pre-existing appointments of a Textile Expert and an Inspector of Technical Schools.

Private enterprise has already succeeded in making Chota Nagpur, the central division of the Province, one of the principal industrial centres of India, and its vast mineral resources still have many years of further development ahead of them. With the development of the coal resources of the country and of the metallurgical and other larger industries themselves the Department has little direct concern, but one of its principal problems relates to the provision of means whereby Indians may be educated generally

and trained technically to supply both the skilled labour and the skilled supervision which these industries demand and which at present has largely to be imported from abroad. Mr. Collins shows in his report what steps have been taken and what further developments are contemplated to this end by means of Government institutions, aided schools and technical scholarships. Particular interest centres round the foundation of technical institutes at Jamshedpur and Jamalpur.

The smaller industries, particularly those of the 'Cottage' variety, present a different problem. It is here that direct assistance and encouragement are required, and the Director is able to indicate considerable results of the activities of his Department in connection with the hand-weaving industry. He concludes his report with an interesting survey of the industries of the Province, including those already in existence and others in regard to which the natural resources of the country afford a reasonable hope of development. Like others confronted with the task of developing new industries, Mr. Collins alludes to the need for industrial chemists and facilities for research. It is to be hoped that the next few years will witness throughout India a forward policy directed to the provision of this essential basis of industrial progress.

Annual Administration Report of the Department of Industries, Bengal, 1920. 23 PAGES. (CALCUTTA: BENGAL SECRETARIAT BOOK DEPOT. ANNAS 4.)

The Annual Report on the administration of the Department of Industries in Bengal for the year 1920 shows that the activities of the Department cover a wide range. The Department was constituted on a regular and permanent basis during the year under report, and in ad tion to the work of developing local industries it took under its wing in the course of the year the five existing departments which deal with factory inspection, boiler inspection, smoke nuisance, electric inspection and technical and industrial education, while a new appointment of an Industrial Intelligence Officer was created to whom, among other duties,. falls the investigation of labour problems. The Report covers only such of the activities of the Department as fall under the 'transferred' subjects of the development of industries, which includes reseauch, and technical and industrial education.

The organization of the Department, to which has been added an advisory board, was only completed towards the close of the year. Nevertheless, those who ask for concrete results should not be disappointed. The value of the work accomplished at the Calcutta Research Tannery has already been proved by the practical test of the leather market, and it is highly satisfactory to note that the success of investigations carried out at the Tannery into chrome liquors has been recognized in England and America.

The tanning industry does not stand alone in the matter of definite results. Of hardly less importance is the assistance given to the weaving industry by the evolution and supply of improved machinery, the demonstration of its working to weavers and the instruction of students at the Weaving Institute at Serampore and at outlying centres. Nor has assistance been confined to the cottage industry, for the establishment of two mills is to be reckoned among the achievements of the Department.

Technical and industrial education covers such diverse branches as training in survey work, weaving, a commercial institute, a school of art and instruction in mining, and the figures of attendance with the results of examinations show that the young men of Bengal are taking advantage of the opportunities offered to them to obtain the preliminary training necessary for an industrial career.

The Department felt the want of an Industrial Chemist, but the supply of this deficiency is doubtless only a question of time.

LIST OF PUBLICATIONS RECEIVED IN THE DEPARTMENT OF INDUSTRIES, GOVERNMENT OF INDIA

(From 1st July to 30th September 1921)

I. Books

Experiments in Industrial Organisation. By Edward Cadbury. 296 pages. (Calcutta : Longmans, Green and Co. 15*s*.)

Oil and Petroleum Manual. By W. R. Skinner. 320 pages. (London : Clement's Lane. 7*s*. 6*d*.)

Profit Sharing By A. Trombert. 92 pages. (P. S. King and Sons, Ltd. 2*s*. 6*d*.)

Scientific Management. A History and Criticism. By H. B. W. Drury. 251 pages. (London : Longmans, Green and Co. 8*s*.)

The Industrial Clinic. Edited by E. L. Collis. 239 pages. (London : John Bale Sons and Danielsson. .0*s*. 6*d*.)

Text-Book of Inorganic Chemistry, Vol. IX. Pt. II. Iron and its Compounds. By J. N. Friend. 265 pages. (London : Charles Griffin and Co., Ltd. 18*s*.)

Conflicts of Capital and Labour. By George Howell. 536 pages. (London : Macmillan and Co. 10*s*. 6*d*.)

Manual for the Oil and Gas Industry under the Revenue Act of 1918. By Arnold, Darnell and others. 190 pages. (New York : John Wiley and Sons. 15*s*.)

Principles of Oil and Gas Production. By Johnson and Huntley. 371 pages. (New York : John Wiley and Sons. 15*s*.)

Lubricating and Allied Oils ; A Handbook for Chemists, Engineers and Students. By E. A. Evans. 128 pages. (London : Chapman and Hall. 9*s*. 6*d*.)

Modern Turbine Practice and Water power Plants. By J. W. Thurso. 244 pages. (New York : Robert Drummond. £1 2*s*. 6*d*.)

Kelly's Directory of Merchants, Manufacturers and Shippers of the World. 2 Vols. (£6 8*s*.)

History of Political Economy. By J. K. Ingram. 315 pages. (London: A. and C. Black, Ltd.)

Animal Proteins (Monograph on Industrial Chemistry). By H. G. Bennett. 287 pages. (London: Bailliere, Tindal and Cox. 15*s.*)

Working of Steam Boilers. By E. H. Hiller. 147 pages. (London: Taylor, Garnett, Evans and Co., Ltd. 1*s.* 6*d.*)

Steam Boiler Construction. Rules of the National Boiler and General Insurance Co., Ltd. By E. H. Hiller. 203 pages. (London: Bethell and Co., Ltd. 3*s.* 6*d.*).

Labour's Magna Charta. By Archibald Chisholm. 192 pages. (London · Longmans, Green and Co. 7*s.* 6*d.*)

Economics of Welfare. By A. C. Pigon. 976 pages. (London: Macmillan and Co. £1 16*s.*)

The Acquisitive Society. By R. H. Tawney. 242 pages. (London: G. Bell and Sons, Ltd. 4*s.* 6*d.*)

Women in Trade Unions. By Barbara Drake. 237 pages. (London: Labour Research Department. 8*s.* 6*d.*)

Year-book of the Scientific and Learned Societies of Great Britain and Ireland. 354 pages. (London: Charles Griffin and Co., Ltd. 15*s.*)

Factory Chemistry. By H. Hawkes. 59 pages. (London: Longmans, Green and Co. 4*s.* 6*d.*)

Law Relating to Trade Unions. 2 Vols. By J. H. Greenwood. 302 and 117 pages. (London: Stevens and Sons, Ltd. 10*s.*)

Statesman's Year-Book, 1921. 1,544 pages. (London: Macmillan and Co. £2.)

Application of Electric Power to Mines and Heavy Industries. By W. H. Patchell. 333 pages. (London: Constable and Co., Ltd. 12*s.* 6*d.*)

Wages of Labour. By W. Graham. 165 pages. (London: Casell and Co., Ltd. 5*s.*)

Electrical Practice in Collieries. By Daniel Burns. 407 pages. (London: Charles Griffin and Co. 10*s.* 6*d.*)

Electrical Equipment of Collieries. By Duncan and Penman. 313 pages. (London: Scott, Greenwood and Son. 12*s.* 6*d.*)

Arbitration and Conciliation in Australasia. By M. T. Rankin. 192 pages. (London: George Allen and Unwin. 5*s.*)

Industrial Law. By F. Tillayard. 626 pages. (London: A. and C. Black Ltd.)

Provincial Geographies of India.

(1) *Madras Presidency with Mysore, Coorg and the Associated States.* By Edgar Thurston. 293 pages. (Cambridge University Press. Rs. 4 as. 7.)

Law of the Employment of Labour. By L. D. Clark. 373 pages. (New York: Macmillan and Co. 7*s.*)

The Principles of Political Science. By R. N. Gilchrist. 799 pages. (London: Longmans, Green and Co. Rs. 10 as. 8.)

Fatigue Study. By Gilbreth. 329 pages. (London: George Routledge and Sons. 8*s.* 6*d.*)

Livelihood and Poverty. By A. L. Bowley. 244 pages. (London G. Bell and Sons. 4*s.*)

Elements of Statistics. By A. L. Bowley. 459 pages. (London P. S. King and Sons. £1. 4*s.*)

Electric Furnaces. By J. N. Pring. 485 pages. (London: Longmans. Green and Co. £1 12*s.*)

A Treatise on the Law of Labour Unions. By W. A. Martin. 649 pages (Washington. John Byrne and Co. £2 5*s.*)

Foundations of Indian Economics. By Radhakamal Mukerjee. 515 pages. (London: Longmans, Green and Co. 14*s.*)

Text Book of Physics. By W. Watson. 929 pages. (London: Longmans, Green and Co. 5*s.* 6*d.*)

Economic Possibilities of Kapurthala. By Alakh Dhari. 218 pages. (Allahabad: Pioneer Press.)

Co-operation. By H. R. Crosthwaite. 542 pages. (Calcutta: Thacker Spink and Co. Rs. 6.)

Germany's Commercial Grip on the World. By Henri Hanser. 259 pages. (London: Eveleigh Nash Company. Rs. 5).

Trade Unionism. By H. H. Slesser. 136 pages. (London: Methuen and Co. Ltd. 5*s.*)

Chemistry of Commerce. By R. K. Duncan. 255 pages. (London: Harper and Brothers. 7*s.* 8*d.*)

Economics of Industry. By A. Marshall. 421 pages. (London: Macmillan and Co. 3*s.* 6*d.*)

Effects of War on Property. By Latifi. 155 pages. (London: Macmillan and Co. 5*s.*)

Motive Power in India. By Fakirjee E. Barucha. 71 pages. (Poona: Scottish Mission Industries Co., Ltd.)

Credit Industry and the War. By A. W. Kikaldy. 268 pages. (London: Sir Issac Pitman and Sons. 2*s.* 6*d.*)

A Chapter in India's Currency History. 214 pages. (Bombay: Times Press.)

Industrial Gwalior. By Alakh Dhari. 126 pages. (Gwalior: Alijah Durbar Press.)

Glass Working. By P. N. Hasluck. 160 pages. (London: Cassell and Co., Ltd.)

Punjab Industries 1911-17. By A. C. Badenock. 63 pages. (Lahore: Superintendent, Government Printing. Re. 1.)

Introduction to Crystallography. By Sir W. Phipson. 220 pages. (London: Longmans, Green and Co.)

L'Industrie De Nos Jours. By P. Jacquemart. 686 pages. (Paris: Librairie ch. Delegrave.)

Chemical Discovery and Invention in the 20th Century. By Sir W. A. Tilden. 487 pages. (London: George Routledge and Sons. 7*s.* 8*d.*)

Address on Industrial Development. By H. Cox. 16 pages. (London: William Clowes and Sons.)

Generation of Power in Mysore. By Sir Alfred Chatterton. 20 pages. (Bangalore: Vokkaligara Sangha Press.)

Development of Mechanical Engineering in India. By Sir Alfred Chatterton. 18 pages. (Bangalore: National Press.)

Improved Method of Making Jaggery. By Sir Alfred Chatterton. 12 pages. (Bangalore: Vokkaligara Sangha Press.)

Indian Finance Currency and Banking. By S. V. Doraiswami. 176 pages. (Madras: S. V. Doraiswami Mylapore. Rs. 2 as. 8.)

Lift Irrigation. By Sir Alfred Chatterton. 354 pages. (Madras: G. A. Natesan and Co. Rs. 2.)

Shop Management. By F. W. Taylor. 207 pages. (London: Harper and Brothers. 7*s.* 6*d.*)

First Year of the League of Nations. By C. G. Wilson. 94 pages. (Boston: Little, Brown and Co. 7*s.* 6*d.*)

Annual Reports of Trade union Congress for 1909, 1911, 1913, 1915, 1919, 1920. 206, 368, 408, 280, 431, and 432 pages. (London: Co-operative Printing Society, Ltd. 3*s.* 6*d.* each.)

Dress and Insignia Worn at His Majesty's Court. By Herbert A. P. Trendell. 202 pages. (London: Harrison and Sons, Ltd. Rs. 21 as. 8.).

Law of Combinations, Monopolies and Labour Unions. By F. H. Cook. 466 pages. (Chicago: Callaghan and Co. £2 7*s.* 6*d.*)

Scientific Management. By Thompson. 878 pages. (Cambridge: Harvard University Press. 19*s.*)

Scientific Management and Labour. By R. F. Hoxie. 302 pages. (New York: D. Appleton and Co. 12*s.* 6*d.*)

Fuel Problems of the Future. By Berlhoy. 31 pages. (London: Institution of Civil Engineers, Great George Street, Westminster.)

Mind and Work. By C. S. Myers. 204 pages. (London: London University Press. 6*s*)

Official Statistics. By A. L. Bowley. 63 pages. (Humphrey Milford: Oxford University Press. 2*s.* 6*d.*)

Cotton Spinning. By A. S. Wade. 102 pages. (London: Sir Isaac Pitman and Sons, Ltd. 2*s.* 6*d.*)

Health of the Industrial Worker. By E. L. Collis and Major Greenwood. 450 pages. (London: J. and H. Churchill. 30*s.*)

Agricultural Insurance. By. J. S. Chakravarti. 567 pages. (Bangalore: Government Press. Rs. 4 as. 12.)

The Times of India Directory, 1921. 1776 pages. (Bombay: The *Times of India* Office. Rs. 12.)

Reports on Jute and Silk. 90 pages. (London: John Murray. 5*s.*)

Reports on Timbers and Paper Materials. 57 pages. (London: John Murray. 4*s.*)

Bombay University Calendar, 1920-21. 2 vols. 662 and 553 pages. (Bombay: Government Central Press. Rs. 3 and Rs. 2.)

Madras University Calendar, 1921. Vol. I. 678 pages. (Madras: Associated Printers, Ltd. Re. 1.)

Mysore University Calendar, 1920-21. 2 vols. 370 and 405 pages. (Mysore: Government Branch Press.)

Punjab University Calendar, 1920-21. 2 vols. 649 and 1019 pages. (Calcutta: Baptist Mission Press.)

South India and Her Muhammadan Invaders. By S. Krishnaswamy Aiyangar. 257 pages. (Humphrey Milford: Oxford University Press.)

II. Official Publications

(*a*) *H. M. Stationery Office, London*

Publications of the Imperial Mineral Resources Bureau: (1) Manganese, (2) Coal, Coke and By-Products, (3) Talc, (4) Felspar and Fluorspar.

Imperial Mineral Resources Bureau—Statistical Summary of Production, Export and Import during 1913-20.

Report on the Electrical Cable Industry under the Profiteering Acts, 1919 and 1920.

Report on States under the Profiteering Acts, 1919 and 1920.

Report on Uniform Clothing under the Profiteering Acts, 1919 and 1920.

Report on the Repairing of Boots, Shoes and Footwear under the Profiteering Acts, 1919 and 1920.

Report on the Explosives Industry under the Profiteering Acts, 1919 and 1920.

Report on Vinegar under the Profiteering Acts, 1919 and 1920.

Final Report on Meat under the Profiteering Acts, 1919 and 1920.

Report on Dyeing, Finishing, Bleaching and Printing under the Profiteering Acts, 1919 and 1920.

Report on Dyes and Dyestuffs under the Profiteering Acts, 1919 and 1920.

Report on Dyeing and Cleaning under the Profiteering Acts, 1919 and 1920.

Report on Pottery under the Profiteering Acts, 1919 and 1920.

Final Report on the Glassware Trade under the Profiteering Acts, 1919 and 1920.

Report on the Sale and Hire of Gas Apparatus under the Profiteering Acts, 1919 and 1920.

Reports of the Industrial Fatigue Research Board, Nos. 5, 8, 9, 10, 11 and 13.

Report on Enquiry into Industrial Agreements.

The Science of Ventilation and Open Air Treatment. Pts. 1 and 2.

The Mortalities of Birth, Infancy and Childhood.

First Report of the Special Investigation Committee upon the Incidence of Phthisis in Relation to Occupations.

Inquiry into the Prevalence and Ætiology of Tuberculosis among Industrial Workers, with Special Reference to Female Munition Workers.

Earnings and Hours Enquiry Report. Vols. I to VIII.

Report on Trade Unions 1908-1910.

Report on Industrial and Agricultural Co-operative Societies in the United Kingdom (with Statistical tables).

Fourth Abstract of Foreign Labour Statistics.

Seventeenth Abstract of Labour Statistics of the United Kingdom.

Report on Profit Sharing and Labour Co-partnership in the United Kingdom.

Report of the Royal Commission on Trade Disputes and Trade Combinations.

Report to the Board of Trade on Agencies and Methods for Dealing with the Unemployed in Certain Foreign Countries.

Second Report on Rules of Voluntary Conciliation and Arbitration Boards and Joint Committees.

Code of General Instructions for Registration and Placing of Applicants for Employment.

Decisions under the Industrial Courts Act, 1919. Vols. I to III, Vol. III in 3 parts.

Departmental Committee on Disinfection of Horsehair.

Rules under the Government of India Act, 1919.

List of Occupations with Index.

Army and Air Force Act, 1921.

Collected Researches of the National Physical Laboratory, Vol. XV, 1920.

Report of the National Physical Laboratory for the Year 1920.

(*b*) Government of India

Proceedings of the First Meeting of the Agricultural Chemists and Bacteriologists of the Board of Agriculture, held at Pusa on the 24th February 1919.

Proceedings of the 3rd Meeting of Mycological Workers in India held at Pusa on the 7th February 1921.

Railway Police Committee Report

Indian Sugar Committee Report.

Forest Records. Vol. viii, Pt. II. The Regeneration of *Sal* Forests (*Shorea robusta*).

Records of the Geological Survey of India. Vol. LII and Pt. I of LIII.

Memoirs of the Department of Agriculture in India—

- Veterinary Series. Vol III, No. 2.
- Entomological Series. Vol. VII, Nos. 4 and 5.
- Botanical Series. Vol. XI, No. 5.

Civil Account Code. Vols. 1 and 2. 8th edition.

Madras Presidency, Jails Administration Report 1920.

Criminal Procedure Code, 1898 (as modified up to 1920).

Co-operative Societies in the United Provinces. By S. H. Freemantle.

Report on the Zoological Survey of India, 1917-20.

Agricultural Research Institute Bulletins (1920 and 1921)—

No. 96 of 1920. Summary of the Experiments on Rice in Bihar and Orissa from 1912-19.

No. 117 of 1921. Experiments with Castor Seed Conducted at Sabour.

No. 118 of 1921. The Saving of the Irrigation Water in Wheat Growing.

No. 119 of 1921. Agricultural Development of Baluchistan.

No. 120 of 1921. The Serum Simultaneous Method of Inoculation against Rinderpest.

No. 121 of 1921. Notes on Contagious Abortion in Pony and Donkey Mares.

No. 122 of 1921. Pusa 12 and Pusa 14 in the Central Circle of the United Provinces.

No. 124 of 1921. Safflower oil.

Agricultural Research Institute Indigo Publications—

No. 9. Nature of the changes Occurring during the Extraction of Indigo from the Java Plant.

No. 10. Note on the Deterioration of Indigo Seed during Storing.

Report on Public Instruction in Bengal, 1919-20.

Annual Report on the Working of the Indian Factories Act in Bengal, Bihar and Orissa and Assam, 1920.

Note on the Mineral Production of Burma during 1920.

Vegetable Oil Industry in the Bombay Presidency (Bombay Industries Department Bulletin No. 3).

Handbook of Tanning (Department of Industries, Bengal).

Bengal, Industries Department—Progress Report—

For the Month of April 1921.

For the Month of May 1921.

Calcutta Research Tannery. Report on the Investigation on Indian Tannery Waters.

Progress Report of the Calcutta Research Tannery for the quarter ending 30th September 1920.

The Indian Penal Code, 1860, with amending Acts up to 1920.

(c) *League of Nations*

Report of the Delegates of India to the first Session of the Assembly of the League of Nations.

Organisation of the Secretariat and of the International Labour Office.

Audit of Accounts for the Second Financial Period of the International Labour Office. April 1st to December 31st, 1920.

Supplementary Report on certain Countries, Reports I, II, and III.

(d) *International Labour Office*

Trade Union Conditions in Hungary.

The International Seamen's Code.

Enquiry concerning the Application of the Eight-Hour Act in the French Mercantile Marine.

First Comparative Report on the Administration of Labour Laws.

Labour and Production in the Ruhr Coal Field.

Regular Periodical Publications

1. International Labour Review.
2. Official Bulletin.
3. Daily Intelligence.

Irregular Periodical Publications

1. Studies and Reports—A to F, H and K.
2. Bibliographical Series.
3. Legislative Series.

(e) *Australia*

Arbitration and Wage-Fixing in Australia. Research Report No. 10.

Report of the Royal Commission on the basic wage.

(*f*) *Canada*

Report of the Department of Labour for the fiscal year ending March 31, 1920 .

Eighth Annual Meeting of the International Association of Public Employment Services.

(*g*) *United States*

Works Committees and Joint Industrial Councils, Report.

Historical Survey of International Action affecting Labour, 1920

Industrial Survey in selected Industries in the United States 1919.

Bureau of Mines, Bulletins, Washington

No. 16. The Uses of Peat for Fuel and Other Purposes.
No. 20. The Explosibility of Coal Dust.
No. 24. Binders for Coal Briquettes.
No. 50. Laboratory Study of the Inflammability of Coal Dust.
No. 58. Fuel-briquetting Investigations.
No. 60. Hydraulic Mine Filling.
No. 71. Fuller's Earth.
No. 77. The Electric Furnace in Metallurgical Work.
No. 87. Houses for Mining Towns.
No. 106. The Technology of Marble Quarrying.
No. 115. Coal-Mine Fatalities in the United States, 1870—1914.
No. 128. Refining and Utilization of Georgia Kaolins.
No. 132. Siliceous Dust in Relation to Pulmonary Disease among Miners in the Joplin District, Missouri.
No. 133. The Wet Thiogen Process for Recovering Sulphur from Sulphur Dioxide in Smelter Gases.
No. 136. Deterioration in the Heating Value of Coal during Storage.
No. 139. Control of Hookworm Infection at the Deep Gold Mines of the Mother Lode, California.
No. 148. Methods for Increasing the Recovery from Oil Sands.
No. 173. Manganese.

Bureau of Mines Technical Papers. Nos. 13, 21, 82, 84, 110-112, 134, 138, 140, 177, 178 to 178B and 178D, 181, 186, 225, 227, 230 and 233.

(h) *Proceedings and Miscellaneous Reports*

Proceedings of the Indian Science Congress

2nd Science Congress, Madras, 1915
3rd Science Congress, Lucknow, 1916
4th Science Congress, Bangalore, 1917
5th Science Congress, Lahore, 1918
6th Science Congress, Bombay, 1919
7th Science Congress, Nagpur, 1920

(i) *Official Gazettes, Reviews, etc.*

Labour Gazette, London
Labour Overseas, London
Industrial Gazette, Queensland, Brisbane
Statistical Bulletin, N S W, Sydney
Labour Gazette, Canada, Ottawa
Statistical Abstract, Perth West Australia
Abstract of Statistics, New Zealand, Wellington
N S W. Industrial Gazette, Sydney
Bulletin Du Ministére Du Travail
Bulletin de La Société de Chimia Industrielle
Labour Review, Washington
International Labour Review, Geneva
Postal Union Bulletin, Lucknow
Labour, Calcutta
Swadharma, Madras.

EXCHANGE LIST

THE FOLLOWING PERIODICALS ARE RECEIVED REGULARLY IN EXCHANGE FOR THE PUBLICATIONS OF THE DEPARTMENT OF INDUSTRIES, GOVERNMENT OF INDIA.

India

Business World, Madras.
Indian Business, Bombay.
East and West, Simla.
The *Hindustan Review*, Allahabad.
The *Indian and Eastern Engineer*, Calcutta.
Industry, Calcutta.
The *Indian Review*, Madras.
The *Indian Textile Journal*, Bombay.
The *Journal of Indian Economic Society*, Bombay.
The *Journal of the Bombay Branch, Royal Asiatic Society.*
Journal, Proceedings and Memoirs of the Asiatic Society of Bengal.
The *Modern Review*, Calcutta.
The *Mysore Economic Journal*, Bangalore.
The *Postal Union Bulletin*, Lucknow.
Proceedings of the Indian Science Congress.
Scientific World, Lahore.
Transactions of the Mining and Geological Institute of India.
The *Wealth of India*, Madras.

Abroad

The *Analyst* (Society of Public Analysts and other Analytical Chemists), London.

Annual Reports and *Collected Researches* (The National Physical Laboratory), Teddington, Middlesex.

Annual Report and Journal of the Society of Chemical Industry, London.

The *Asian Review*, Tokyo.

Bulletins of the Administration of the South African Railways and Harbours, Johannesburg.

Bulletins of the Imperial Institute, London.

The *Canadian Export and Oversea Markets Review*, London.

The *Chemical Age*, London.

The *Chemical News and Journal of Physical Science*, London.

Chimie et Industrie, Paris.

Cotton (The Manchester Cotton Association, Ltd.), Manchester.

Das Handelsmuseum and *Nachrichten des Handelsmuseum und Konsularkorrespondenz* (Ministry of Commerce, Government of Austria), Vienna.

Helvetica Chemica Acta, Basel (Switzerland).

The *Indian and Eastern Druggist*, South Croydon.

The *Industrial League and Council Journal*, London.

The *Journal of Industrial Welfare* (Industrial Welfare Society), Westminster.

The *Journal of the American Chemical Society*, and The *Journal of Industrial and Engineering Chemistry* (Ohio State University), Columbus, Ohio.

The *Journal, Library Bulletin* and *Year Book of the Franklin Institute*, Philadelphia.

The *Journal of the Royal Society of Arts*, London.

The *Journal of the Textile Institute*, Manchester.

The *Labour Gazette* (Department of Labour, Canada), Ottawa.

The *Leather World*, London.

The *Labour Gazette* (Ministry of Labour), London.

The *New South Wales Industrial Gazette* (Department of Labour Industry), Sydney.

The *Perfumery and Essential Oil Record*, London.

The *Philippine Journal of Science* (The Government of Philippine Islands, Department of the Interior Bureau of Science), Manila.

The *Pharmaceutical Journal* (Pharmaceutical Society of Great Britain), London.

Publications of the United States Department of Agriculture, Washington.

The *Queensland Industrial Gazette* (Department of Labour), Brisbane.

The *Shoe and Leather Record*, London.

The *South African Journal of Industries* (Union of South Africa, Department of Mines and Industries), Pretoria.

The *Monthly Abstract of Statistics* (The Government of New Zealand), Wellington.

The *Quarterly Statistical Bulletin* (The Government of New South Wales), Sydney.

The *Quarterly Statistical Abstract* (Government of Australia), Perth.

Revue du travail (Ministere de l'Industrie, du Travail et du Revitaillement), Brussels.

The *Textile Mercury*, Manchester.

Weltwirtschaftliche Nachrichten (Institut fur Seeverkehr und Weltwirtschaft), Kiel.

BULLETINS OF INDIAN INDUSTRIES AND LABOUR

Abstracts

I.—GENERAL

Proceedings of the first Conference of Directors of Industries. *Bulletin No. 1*, 96 pages. (Re. 1.)

Held at Simla on the 12th, 13th and 14th April 1920 President's opening speech. Principal subjects discussed : (*i*) The constitution of an All-India Industrial Service. (*ii*) Co-operation between the Central and Provincial Departments of Industries. (*iii*) Technical and industrial education and apprenticeship schemes. (*iv*) Labour questions. (*v*) Financial and other forms of assistance for new industries : pioneer and demonstration factories. (*vi*) Standardization of machinery and plant with a view to their manufacture in India. (*vii*) Unification of the laws and regulations relating to boilers. (*viii*) British Empire Exhibition.

Proceedings of the second Conference of Directors of Industries. *Bulletin No. 5*, 96 pages. (12 As)

Held at Cawnpore on the 1st, 2nd, 3rd and 4th November 1920. President's opening speech. Principal subjects discussed : (*i*) Industrial policy of local Governments, etc. (*ii*) Financial and other form of assistance to industry. (*iii*) Pioneer and demonstration factories. (*iv*) System of accounts to be adopted in Government factories. (*v*) Works committees. (*vi*) Census of production. (*vii*) Labour statistics. (*viii*) Regulation of jail industries. (*ix*) British Empire Exhibition.

Chemical Researches in Progress. *Bulletin No. 13*, 12 pages. (2 As.)

A list of chemical researches of industrial value which are being conducted in Government institutions and colleges.

Factory Construction and Installation in Bengal. A. T. Weston. *Bulletin No. 14*, 29 pages. (5 As.)

Main conditions to which attention should be given to ensure proper foundations for industrial enterprise. Location of site. Layout of buildings and grounds. Design of buildings. Machinery. Power plant and fuel supply. Essential welfare conditions.

Notes on Indian Piece Goods Trade. A. C. Coubrough. *Bulletin No. 16*, 15 pages. (8 As.)

Consumption of imported piece goods in India. Production and profits of Indian mills. Illustrated by five graphs.

Proceedings of the third Conference of Departments of Industries. *Bulletin No. 18*, 166 pages. (Re. 1 As. 4)

Held at Simla on the 23rd, 24th, 25th and 26th May 1921. President's opening speech. Principal subjects discussed: (*i*) Co-ordination of work of Directors of Industries and the Commercial Intelligence Department. (*ii*) The hydro-electric survey of India. (*iii*) Shortage of coal for small industries. (*iv*) Advisory Boards of Directors of Industries. (*v*) State technical scholarships. (*vi*) Constitution of an All-India Industrial Service. (*vii*) Constitution of an All-India Chemical Service. (*viii*) Appointment of Indian Trade Commissioners in foreign countries. (*ix*) Deputation of officers to other countries to study State aid afforded for the development of industries. (*x*) Industrial banks. (*xi*) Government loans or other financial aid to small industrialists. (*xii*) Development boards.

Chemicals manufactured in India. *Bulletin No. 21*, 40 pages. [In the Press.]

A list of chemicals, excluding drugs, manufactured by firms in India.

II.—LABOUR

The International Labour Organisation. A. G. Clow. *Bulletin No. 4*, 123 pages. (14 As.)

The formation of the International Labour Organization of the League of Nations and its activities up to and including the first

meeting of the International Labour Conference at Washington. The Draft Conventions and Recommendations adopted by the Conference.

Indian Factory Law Administration. A. G. Clow. *Bulletin No. 8,* 49 pages. (7 As.)

A history of Indian factory legislation and its administration. Various aspects of factory laws affecting the employment of women and children, the health and safety of labour, etc.

The Washington Labour. Conference (official correspondence). *Bulletin No. 10,* 139 pages. (Re. 1 and as. 8)

A sequel to *Bulletin No. 4,* 'The International Labour Organisation.' Action taken in India on the proposals made at Washington up to the opening of the first session of the reformed Legislature at Delhi in February 1921.

Genoa Labour Conference (official correspondence). *Bulletin No. 17,* 87 pages. (Re. 1)

An account of the Genoa Labour Conference with the text of the Draft Conventions and Recommendations adopted by it concerning employment of labour at sea. Action taken in India on the proposals made at Genoa up to the opening of the autumn session of the reformed Legislature at Simla in September 1921.

III.—MINERAL

A series of monographs dealing with the manner in which manufacturers obtain and utilize their supplies, the system of buying and selling, the recognized market grades and units of sales of the mineral, etc. Statistics showing consumption and re-exports from the United Kingdom and other countries. Pre-war, war and possible post-war conditions and the outlook for the future in the light of data regarding competing sources of supply. Industrial uses of the mineral; specifications and standards of quality demanded in the trades concerned. A brief description of the mineral, its distinctive characteristics and its occurrences in India.

Notes on manganese ores. J. Coggin Brown. *Bulletin No. 2*, 31 pages. (4 As.)

Notes on magnesite and monazite. J. Coggin Brown. *Bulletin No. 3*, 34 pages. (6 As.)

Notes on antimony, arsenic and bismuth. J. Coggin Brown. *Bulletin No. 6*, 28 pages. (4 As.)

Notes on wolfram. J. Coggin Brown. *Bulletin No. 7*, 22 pages. (3 As.)

Notes on chromite and molybdenum. J. Coggin Brown. *Bulletin No. 9*, 31 pages. (4 As.)

Notes on tin. J. Coggin Brown. *Bulletin No. 11*, 32 pages. (4 As.)

Notes on bauxite, borax, corundum and garnet. J. Coggin Brown. *Bulletin No. 12*, 54 pages. (10 As.)

Notes on mica. J. Coggin Brown. *Bulletin No. 15*, 45 pages. (9 As.)

Notes on zinc and lead. J. Coggin Brown. *Bulletin No. 19.* [In the Press.]

Notes on asbestos. J. Coggin Brown. *Bulletin No. 20.* [In the Press.]

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